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ABSTRACT

A comparative analysis was made of two vastly different educational innovations: the children's television program "Sesame Street," and the computer-assisted instruction (CAI) programs of the Institute for Mathematical Studies in the Social Sciences. The study was complicated by their distinct objectives and by their widely different means of delivery. The Children's Television Workshop, creators of "Sesame Street," concentrated on an inter-city target audience but achieved a much broader appeal. The numbers of viewers have increased and there have been measurable gains in the viewers cognitive development. Conclusive results about CAI are not yet available because of its limited deployment and the constantly changing state of the technology. With the recent introduction of more reliable terminal hardware and more sophisticated instructional programs, computers are expected to become more effective and less expensive. (EMH)

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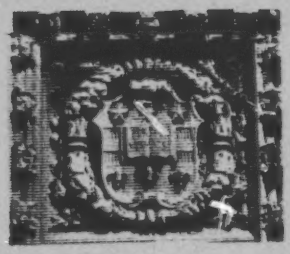

WASHINGTON UNIVERSITY

CENTER FOR DEVELOPMENT TECHNOLOGY

CASE STUDIES OF INNOVATION IN THE EDUCATIONAL SERVICE SECTOR

BY

DONNA ROTHENBERG
ROBERT P. MORGAN

With Contribution By

Lane Gustafson

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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	v
LIST OF FIGURES	v
Chapter	
1. INTRODUCTION AND OVERVIEW	1
References	8
2. THE CHILDREN'S TELEVISION WORKSHOP AND "SESAME STREET"	9
I. Introduction, Objectives, and Overview of the Investigation	9
II. The Innovation and the Motivation Behind It	14
III. The Subsector (The Environment): The American Television Scene	17
IV. The Inventing (Or Initiating) Unit: The Children's Television Workshop	21
V. The Innovation: "Sesame Street"	26
VI. Techniques of Change: Factors and Procedures Affecting Adoption/Use. Skillfully Marshalling Public Consciousness Behind the Innovation	30
VII. The Adopters: The Non-Commercial Broadcasting Establishment	34
VIII. The Users: Pre-Schoolers and their Families	40
IX. Impact of the Innovation: Consequences and Evaluation	43
X. Summary Analysis	52
References	60

TABLE OF CONTENTS
(continued

Chapter		Page
3.	INSTITUTE OF MATHEMATICAL STUDIES IN SOCIAL SCIENCES: COMPUTER-ASSISTED INSTRUCTION.	62
	I. Introduction.	62
	II. The History of the Initiating Unit and The Innovation.	65
	III. The Subsector (Environment); The American Educational Scene	73
	IV. The Innovation: Computer-Assisted Instruction	80
	V. Techniques of Change: Factors Affecting the Adoption and Use of the Innovation.	91
	VI. The Adopters: School Systems and Their Representatives	98
	VII. The Users: Elementary School Students.	108
	VIII. The Impact of the Innovation: Evaluation	116
	IX. Summary Analysis.	128
	References	134
4.	COMPARATIVE ANALYSIS; ISSUES AND POLICY IMPLICATIONS: FUTURE RESEARCH.	140
	I. Comparative Analysis of the "Sesame Street" and "IMSSS-CAI" Cases	140
	II. Some Observations and Issues Concerning The Innovation Process.	149
	III. Policy Implications; Recommendations for Further Research.	158
	References	163

LIST OF TABLES

Table		Page
1.	Stanford Programs in Computer-Assisted Instruction	70
2.	Number of Computer Projects Funded by the U.S. Office of Education (by years).	71
3.	List of Participating Schools in Drill-and-Practice Program.	100
4.	Organizations Involved in the Region 7 CAI Project	106

LIST OF FIGURES

Figure		Page
1.	Organizational Flow Chart, Stanford CAI Project.	89

Chapter 1: INTRODUCTION AND OVERVIEW

> There is a certain relief in change, even though it be from bad to worse; as I have found in travelling in a stage-coach, that it is often a comfort to shift one's position and be bruised in a new place.
>
> Washington Irving, Tales of a Traveller

This report contains the results of an investigation of innovation in the educational service sector. Two case studies of innovation in education have been carried out which provide the central focus of our work. The first case concerns the Children's Television Workshop (CTW) and its "Sesame Street" pre-school educational television program. The second case focuses upon computer-assisted instruction (CAI) for elementary education developed at the Institute of Mathematical Studies in the Social Sciences (IMSSS) at Stanford University. Based upon the case studies, an analysis is then presented which seeks to provide information and insights which will be useful to educational policymakers and others who are concerned with the process of innovation in education, and with educational improvement in general.

In its own highly faceted way, this report is a reflection of contemporary society with its expectation of change. Within recent years, individuals have experienced changes of extraordinary scope and increasing acceleration. An important factor leading to change is innovation, a word connoting the concept of change in league with the concept of novelty or newness, be it a new procedure, technology, theoretical construct, ideology, or whatever. It is understandable then that governments have an interest in comprehending the process of innovation so that they are better equipped to provide services to their respective citizenry within the environment in which they must operate.

This investigation was supported by the National Institute of Education (NIE), which was created to conduct research on issues affecting American education in order to aid in policy formulation and result in educational improvement. Both case studies deal with innovations which are to varying degrees technological, and therefore also should be of interest to those concerned with the application of technology to education. NIE includes a Task Force on Finance and Productivity which is interested in that issue, as shown by its involvement with the "open" University of Mid-America project and the education component of the first year of the ATS-6 communication satellite demonstration. It is hoped that the case studies and analysis presented in our report will assist educational policy makers in developing a clearer understanding of the consequences of government policies used to foster innovation in education. It is also hoped that our work will stimulate further investigation of mechanisms by which government can constructively influence the innovative process, and of criteria for selecting which innovations to support.

Several considerations prompted our selection of the CTW-"Sesame Street" and CAI-IMSSS innovations as case studies. First, it was felt that sufficient information on each of these cases would be available so as to provide useful insight into the organizational, adoptive, and evaluative phases of the innovative process. Second, both innovations had been spawned sufficiently far in the past so that a somewhat complete picture of what had transpired could be obtained. As we progressed into the work, it appeared to us that the dissimilarities and differences between the cases were such that further refinement of the issues under study could be obtained by a comparative analysis of the two cases. Such an analysis is included in Chapter IV.

Both innovations were initiated in the 1960's, a period during which a dominant feature of the scene in the United States was social concern and attempts at social reform. "The Great Society" became the catch-phrase for the spirit to improve the quality of American life through a myriad of social programs. The education sector was the subject of much attention and the beneficiary of much funding and programmatic effort, which is reflective of a phenomenon that is widely recognized as the American belief in education and less often expressed as the American belief in education's function as a change agent. This line of reasoning holds that one important means of effectuating a "Great Society" was to improve education and to reach underserved student bodies so that the benefits accruing from the educational process would be more equitably distributed, and more Americans would have access to a better life. Although both innovations were viewed as having applicability to children of all socio-economic strata, their applicability to children traditionally underserved by the existing educational system was quickly perceived. Therefore, the 1960's were supportive of educational innovation and may be considered the environment in macrocosm which spawned these innovations.

"Sesame Street" had the potential for initially reaching 70 percent of its intended audience because it was distributed via open-circuit television, an omnipresent medium in America. The program could enter private homes, nursery schools, and day care centers, the logical places to find its pre-school aged audience. National distribution was over the non-commercial television interconnection; although this was not as well established either institutionally or technologically as the commercial television networks, "Sesame Street" could be disseminated

rapidly on a nationwide scale with a minimum of disruption. The adopters were the local public broadcasting stations, not the schools. The IMSSS curriculum was distributed initially to student computer terminals located at schools which were "tied" to the Stanford University computer by telephone longlines. By contrast with the fast dissemination of a somewhat "familiar" television product in the "Sesame Street" case, CAI represented a much newer, less familiar entity at a much earlier stage of development, with no large scale dissemination network available. Adoption of the IMSSS computer-assisted instruction meant the emplacement of a new technology in schoolrooms and it meant decisions by individual schools to use their own resources to some extent.

One may already sense the challenges inherent in this study. How is new technology introduced into American schools? Educational establishments have not been the most receptive to the electronic media, although radio and television are used to some extent and small-scale technologies such as films and audio tapes are also employed. How do innovators use open-circuit television for educational purposes and entice large numbers of viewers? American television has been dominated by entertainment programming, and national taste has been conditioned to non-instructional fare. How does a new development, computer-aided instruction, which requires new forms of student interaction attempt to establish itself in schools? By using the framework of case studies in innovation, these questions, among others, will be probed.

Studies of innovation have been conducted within many disciplines and along interdisciplinary lines.[1,2,3]* Accordingly, the study of innovation may be considered a hybridization of many fields, as communication theories, psychological considerations, economic concepts, and sociological constructs

*References are numbered consecutively beginning with number one within each chapter and are listed at the end of each chapter.

intermingle to form the broad conceptual outline of the innovation process. There is a substantial body of literature on this topic, much of which is specific to education. Innovation researchers [4, 5] seem to classify this literature as falling into one of two broad categories: 1) theoretical constructs of educational innovation, as characterized by the writings of Havelock,[6] or 2) reports of actual innovations, largely narrative in character displaying a limited research orientation, and much of which is described as in an "advocacy mode" of reporting.[4, 5] Each type of literature has certain failings. Theoretical writings attempt to develop intricately-structured typologies without sufficient account of the institutional framework into which the innovation must be integrated. Narrative reports merely reconstruct rather than analyze case histories, producing somewhat the opposite effect of over emphasis on the particular setting and little data which might form the basis of comparison with innovations cited elsewhere.[4, 5]

As a guide for developing our case studies, we chose to use guidelines put forward by the Secretariat for Science and Technology of the Organization for Economic Cooperation and Development (OECD).[7] These guidelines were designed for use in an OECD multinational study of innovation in the public service sector. Among the elements considered in the OECD guidelines were:

1. Nature of the Problem and History of the Innovation
2. The Subsector (The Environment)
3. The "Inventing" (or Initiating) Unit
4. The Innovation
5. Techniques of Change: Factors and Procedures Affecting Adoption/Use
6. The Adopters

7. The Users

8. Impact of the Innovation: Consequences and Evaluation

A model of innovation which OECD used in establishing these guidelines may be interpreted as follows. Innovation in a service sector is viewed as a multi-step process involving a number of parties. A motivating situation, be it an idea, need, milieu, or environment ("the nature of the problem" and "the subsector (environment)") prompts a change agent ("initiating or innovating unit") to produce an innovation which then must be brought into more general acceptance through procedures designed to effectuate its adoption ("techniques of change"). The innovation process will unfold in one or two phases, depending upon the immediacy of the intended audience for the innovation ("the users") to the change agent. The users may be reached and prevailed upon directly by the innovators, or the users must be reached through an intermediary or adopting unit ("the adopters"). Once the cycle has been completed, the focus is upon how well the innovation fared (based upon selected criteria) and what consequences followed ("consequences and evaluation"). It should be pointed out that we have used the guidelines gleaned from this model as a tool to facilitate discussion. Detailed examination of the suitability of this model or other models to characterize the general process of innovation in education is beyond the scope of this investigation.

The first case study presented will be that of "Sesame Street", and it will comprise the entirety of Chapter II. The examination begins by developing an understanding of why this program is viewed as innovative. A brief description of the innovation follows and the forces motivating its creation are probed against the backdrop of the predominant programming practices in American television during the late 1960's. Attention is

then centered on the innovation process with reference to the principal actors, the innovation itself, and the adoptive strategies employed. The initiating unit in this case is the Children's Television Workshop, an innovation in the organizational sense, which created and produced "Sesame Street," the television program designed to mix entertainment and pre-primary education. The techniques and strategies used to induce adoption of "Sesame Street" and the response of potential funding sources are then probed, followed by studies of the adopters and users — the non-commercial broadcasting establishment, and pre-schoolers and their immediate families, respectively. Consideration is then given to evaluating the impacts and consequences of the innovation. Chapter II ends with a summary analysis.

Chapter III follows essentially the same format with respect to computer-assisted instruction (CAI) for elementary education as developed at IMSSS. The developmental history of the innovation and the initiating unit (the IMSSS) are outlined against the milieu of American education during the 1960's, with special reference to those forces favorable to change. Once again the innovation, principal actors, and adoptive strategies are detailed. An expanded look at computer-assisted instruction as developed at the IMSSS is followed by an examination of the techniques employed to encourage its adoption. The adopters (school systems and their personnel) and the users (elementary school students) are studied in turn. After an evaluation of the innovation's impact, the chapter is concluded with a summary analysis.

The final section, Chapter IV of this report, seeks to analyze the process of innovation in education in general and the role of government in particular, based upon the two previous case studies. A comparative

analysis of the two cases is presented, which highlights similarities and differences. Issues raised and policy implications are considered, along with recommendations for further research.

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Chapter 2: "SESAME STREET" AND THE CHILDREN'S TELEVISION WORKSHOP

I. INTRODUCTION, OBJECTIVES, AND OVERVIEW OF THE INVESTIGATION

This is the first of two case studies detailing innovations in the educational service sector. "Sesame Street" was chosen for study within this context since it represented a programmatic, technology-based innovation which was adopted on a wide scale and which affected not only American early childhood education but primary education as well. Further, it was founded upon an organization, The Children's Television Workshop which was innovative in itself, thus providing elements of procedural innovation which contributed to the ultimate success of the product.

The instance of innovation is clear cut. On Monday, November 10, 1969, the premiere "Sesame Street" production of the Children's Television Workshop aired over nearly 200 television stations across the United States, most of them non-commercial, public television outlets. Preceded by an extensive publicity campaign, "Sesame Street" did not prove to be a disappointment, and rapidly earned widespread kudos for its producers and distributors (public television). Designed to impart learning readiness skills to youngsters between the ages of 3 and 5, particularly those from lower socio-economic and minority groups, the program rapidly attracted an audience which remained loyal and increased as the broadcast season wore on. Youngsters from all socio-economic strata watched, but it was particularly gratifying for the producers to know that children from lower income and minority groups, or those least likely to encounter nursery education, were among the steady viewers. The five-day-a-week, one hour broadcasts were hailed as being in

sharp contrast to the programming offered for children on the dominant commercial networks. At the end of the first broadcast season, "Sesame Street" was evaluated for cognitive effectiveness by a team of outside evaluators from the Educational Testing Service, considered a leader in the field of educational measurement within the United States. According to ETS results, "Sesame Street" was found to be cognitively effective for all viewers, irrespective of individual background. The crucial variables were found to be regularity of viewing, and reinforcement of curriculum in a non-didactic fashion by the viewer's parent. Thus, stamped a critical, cognitive, and public success,* "Sesame Street" has continued to date and is preparing to embark upon its seventh broadcast season in fall, 1975.

This case study opens in Section II with a brief description of the "Sesame Street" innovation and discussion of the forces which motivated its creation. Plans for a television program of this nature were not drawn up in response to a widely-recognized need. Undoubtedly, dissatisfaction with existing children's programming did exist in many quarters. Different approaches tended, however, to dilute any concerted action, branding the situation as one of seemingly endless frustration for disgruntled adult viewers. With the advent of the mid-1960's, the general climate began to change. Attention was focussed on social issues, such as providing equal educational opportunities; more widely available early childhood education was considered an important component of this goal. Federal money was spent to initiate programs intended to rectify inequities and improve matters. Many changes were structured to take place through community organizations, and a new grassroot sentiment permeated the land.

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*Criticisms have, of course, been leveled at the show. For example, one is that "Sesame Street" perpetuates the cognition gap between "advantaged" and disadvantaged" youngsters since it is distributed via the public medium of television which cannot restrict viewership.

Interestingly, a national sense of groping replaced one of confidence, manifest in the willingness of many to "take a chance" and examine alternatives. Out of this apparently incompatible mixture came a climate of receptivity and financial backing for a programmatic innovation on the scale of "Sesame Street."

Yet another perspective on the innovation is given in Section III, which examines the environment that spawned change. In this case, the milieu of American broadcasting, referred to as a "commercial colossus", is probed. Special attention is given to programming designed for children, and the weakness of the non-commercial, e.g., educational, broadcasting system in relation to the dominant commercial system.

Section IV investigates the "Inventing" Unit behind the innovation. "Sesame Street" was created by the Children's Television Workshop, itself a new entity formed in response to the mindless quality of much existing children's television. CTW organizers wanted to educate the very young, whose minds were agile, without abdicating entertainment value -- a formidable task, and one that took three years to refine, fund, and implement. The entrepreneurial factor cannot be overlooked, and the qualities, resources, and goals of both the organizers and the organization are detailed.

Section V analyses the innovation itself. Factors and procedures used to induce sampling and steady viewing of "Sesame Street" are outlined in the following Section VI. Important steps were taken by the Children's Television Workshop to develop an audience. Pre-broadcast promotion was virtually unknown for programs aired over non-commercial television. "Sesame Street," with sufficient funding to ensure a modest publicity budget, disregarded that precedent by retaining experienced public information personnel who functioned within CTW from the onset. Although the program was given much publicity because of its novelty, special efforts

were made to attract the "disadvantaged" target audience, who were not the most likely to be public television viewers. Another important measure was a follow-up component, appropriately enough added during the second, or follow-up season. Relying on trained staffers around the country to guide workers largely drawn from the volunteer ranks, CTW personnel constructed activities to reinforce the curricular material of the show. These were to be administered by volunteer tutors to children attending "Sesame Street" viewing groups. The technique was community outreach to insure meaningful participation.

The non-commercial, e.g. public broadcasting system, became the adopter of the innovation, as discussed in Section VII. "Sesame Street's" primary broadcast outlets were public television stations. This symbiosis between "Sesame Street" and Public Television had important beneficial impacts upon public television. Long considered the stepchild of American broadcasting, the public system was plagued by anemic budgets, limited national coverage (its first interconnection was in 1967), transmission and reception problems, and a splintered sense of mission that confused attempts to cultivate either measureable or loyal audiences. "Sesame Street" not only catapulted the non-commercial system into a favorable public light, but also went far towards melding the distribution system together.

Section VIII examines the intended users of the innovation, pre-schoolers, their parents, and siblings. Section IX concludes with a dual analysis of the innovation. Initially, evaluations conducted of "Sesame Street" are detailed. Evaluations were made of the show's cognitive impact and audience attractiveness. Each type was conducted by outside agencies, cognitive studies being made by the Educational Testing Service with audience measurement conducted by A. C. Nielsen and Daniel Yankelovich and Associates (the latter to assess penetration of urban target audiences). Major

evaluations, of either type, were favorable to the innovation. After one broadcast season, ETS found that "Sesame Street" produced learning gains in viewers, particularly in those instructional areas given most emphasis on the program. Nielsen found a large and expanding audience for the program, and Yankelovich reported respectable viewing patterns for the show among core city residents.

The consequences which flowed from "Sesame Street" are not as easy to quantify, but are explored nonetheless. They may be briefly described as impacts on the adopting system with particular reference to public acceptance, programming initiatives, and the coalescence of individual system components, the last a prerequisite for programming mounted on a national scale. Of more tangential consequence is the effect of "Sesame Street" on subsequent children's programming shown by both public television and the commercial television networks.

Finally Section X provides a limited summary analysis of policy considerations related to the respective roles of government, the public sector, and individuals vis-a-vis the innovation.

Preparation of this case study benefitted from the availability of written materials dealing with "Sesame Street". Of particular utility, were works by Bretz (3) Land, (14) Lesser, (15) Polsky, (18) and Yin (21).

II. THE INNOVATION AND THE MOTIVATION BEHIND IT

Unlike most other nations, the dominant television system in the United States is commercial, or profit-making, rather than government supported. "Sesame Street", the initial production of the Children's Television Workshop aired over non-commercial television throughout the U. S. since the fall of 1969, stands out as a watershed within this context. An hour long, 5-day-a-week program for pre-schoolers designed to develop cognitive skills primarily with some attention given to social skills, "Sesame Street" was innovative in a number of respects: Programmatically it turned out to be a "hit" both critically and in terms of public acceptance; it envisioned its ultimate classroom to be the home, rather than the school, and in so doing rekindled the idea of instruction in an out-of-school setting: Additionally, it represented both an organizational and technological innovation ... organizationally innovative in undertaking an extensive pre-broadcast promotional campaign, devising research strategies which were incorporated into program production, and organizing utilization techniques and personnel to insure meaningful participation by the target audience, and technologically innovative in its reliance upon television and the maximum coverage that medium afforded.

"Sesame Street" was not devised in response to a widely-held, publicly-recognized need or problem. Instead, a set of issues, perceived by different parties, gave rise to both the actual innovation and a climate of receptivity. Growing dissatisfaction with the children's programming commonly seen on commercial television provided much of the impetus. Available data indicated that preschoolers were watching between 30 and 50 hours of television each week, and these findings proved to be the "single most important impetus" to the innovators, according to CTW Secretary Robert Davidson. (23) The "mindless" quality of many shows, the routinization of violence, and the frequency

of commercial messages for the child viewer, disturbed many adults who had occasion to watch children's television. Parental and Congressional ire was nothing new to commercial broadcasters; yet trends in children's programming seemed more vulnerable to economic conditions within the broadcast industry and what programmers assumed to be children's own tastes than to public outcry. Nonetheless, from the late 1960's grassroots sentiment against children's programming practices began to organize. This time other social forces were working in conjunction; new interest in education in general and early childhood education and its social implications in particular, as demonstrated by Project Headstart, continuing concern for providing equality of educational opportunity as manifest by civil rights activity and legislation during this period, gnawing criticism of established institutions ... including commercial broadcasting, and a general sense of malaise replacing euphoria, produced what might be termed a greater willingness on the part of many to "take a chance" and examine alternatives.

One way in which this willingness was reflected was in the renewed interest shown on the part of legislators, foundations, and a few members of the general public for an alternative to the commercial television system. This was to be an uphill battle, for non-commercial, e.g., educational, television was used to a financially-precarious and ignored existence. Serious efforts to upgrade the non-commercial system included landmark legislation providing a base of federal financial support and an organizational rubric to encourage the overlay of national networking upon the existing and strongly autonomous local stations. The Public Broadcasting Act of 1967 created the Corporation for Public Broadcasting (CPB), and in 1970 a distribution service, the Public Broadcasting Service (PBS) was formed. (6,13) The intent was not to crush the bedrock of localism within non-commercial broadcasting, but to create the suprastructure enabling stations to take advantage of the technology for interconnection so that networking

could be arranged, if desired. Additionally, measures were devised to aid program production, to develop program supply on a wider than local level.

Changes in children's programming were coming from another front, representing a different perspective. An unusual working combination of broadcast and pedagogic professionals sparked the formation of a production house sufficiently hybrid to accomodate the efforts of both camps in the development and eventual production of a daily television program to prepare children aged 3 to 5 for school entrance. Now widely known as the Children's Television Workshop (CTW) and recognized as a leading supplier of instructional yet entertaining programs for youngsters, CTW's early history was inauspicious although motivated by concern that contemporary television was failing to use the capacity of young children to learn from the medium even when the material was entertaining or commercial in nature. Working from a New York City base, the Workshop's aim was to reach those youngsters least likely to encounter pre-school programs, generally taken to mean the urban and rural "disadvantaged" population heavily weighted with minority-group children. The entire concept was novel; using a public medium to reach a particular constituency, merging instruction with entertainment in the commercial television mold, all foretold of innovation backed by big budgets. CTW was able to attract funding, first grants for exploratory research graduating into millions for production and distribution, initially because of informal ties between Workshop and private foundation officials. As the scope of the project grew, and its potential for innovative impact on areas of educational priority became clearer, funding from a variety of agencies within the federal government, but principally the U. S. Office of Education, was made available.

III. THE SUBSECTOR (THE ENVIRONMENT): THE AMERICAN TELEVISION SCENE

Video Americana may be described as a two-tier commercial colossus;* or, more literally, a confederation of local television stations and national networks predominately commercial in operation. The relationship between the local outlet and the national network has always been delicate, much of American broadcasting philosophy resting on the theory of strong local stations. In practice, most American television fare is provided by the networks to affiliated stations around the country. This is an acceptable arrangement for both parties; the network is able to sell time to sponsors by providing national coverage while the stations are able to attract viewers with programming that would be too costly to furnish in any other fashion. The magnitude and attractiveness of the network programming service becomes apparent when one considers that the three commercial networks had a $130 million budget for sports coverage in 1971, and that two of the networks had an $82 million budget for news during that year while maintaining the largest news staffs save those for the New York and Los Angeles Times. (13)

Interestingly, United States communication law places the responsibility for what is broadcast upon the local licensee or station operator; thus the networks, prime programming agencies, are unregulated. The constraints upon them operate through affiliate pressure to conform to the dicta of broadcast ethics and public taste or outright refusal to air a program; government generally does not mandate content or program type. Thus, there is ample room for latitude, localism, and change within the system. However, one industry practice with universal applicability is "the ratings," often considered the lifeblood of commercial television. Several

*The descriptive term "commercial colossus" for American broadcasting is used by Timothy Green in his book The Universal Eye.

rating services use different techniques to determine the viewing habits of a random sample of Americans. Statistical methodology is then employed to project those results to figures of national scale. A program's rating (percent of potential audience) and share (percent of actual audience) are projected from these samplings and very often become the measure of its viability.

Programming for children is one part of this milieu. It has served as an "empire builder" in the hands of astute programmers intent upon expanding network coverage by catering to specific audiences. Not usually construed as instructional, programs for the youngsters have ranged from those intended to be expansionary for a particular age group to the solely entertaining, with family-oriented general interest shows overlaying the available choices. Within the past decade, child-oriented programming has tended to be concentrated on week-end mornings or during the "fringe time" hours spanning the return from school and the dinner hour.(17) The economics of children's programming is currently a hotly contested issue among parental watchdog groups such as Action for Children's Television (ACT), the commercial networks, and staff personnel of the Federal Communications Commission, as all parties work toward a solution of the imbroglio regarding the revenue-generating capacity of these shows with their impressionable audiences vis a vis the costs to the networks of providing them. Calculations of a 1972 FCC study by Pearce, as quoted by Melody in his ACT-commissioned study, (17) are that one-half of animated programming ... commonly seen on week-end mornings ... on the average costs between $10 and $11,000,* while a prime-time (between 8-11 P.M. Eastern Time) children's show might cost $250,000 per-hour. Underlying assumptions

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*Reported by Mayer (1972) as $50,000 per first one-half hour showing; generally confirmed by figures quoted in Polsky. (18)

partially explain the differential. The average cost cited for animated fare is based upon an assumed six showings over a two year period; indeed, one characteristic of children's programming is its repeatability or potential for network reruns and eventual off-network syndication, a quality not exclusive of "kidvid," but reflected to a greater degree by that programming subsector. The higher cost of prime-time, first-run fare may be reflective of the higher cost and greater revenue potential of prime-time programming in general.

A logical alternative to commercial "kidvid" is the programming of the non-commercial system. Historically, this has not been realized due largely to the difficulties of the non-commercial system itself. Number of station outlets, poor area and nation-wide coverage, and anemic budgets have gone far towards restricting the viability of channels and programming. Although new stations have come on the air within the past 15 years, expanding to 248 by early 1975, (23) growth has not always been an accurate reflection of competitiveness. For one, 138 of the non-commercial television stations are in the UHF band, implying possible reception problems for area viewers. (5) Sufficient money for production and promotion has been lacking, according to system officials: the Chairman of the PBS Board of Governors was recently quoted by The Wall Street Journal as contrasting his system's $40 million programming budget for 1974 with the estimated $1 billion of the three commercial networks. (8)

Other problems have traditionally plagued non-commercial broadcasting. "Image", for one. An ephemeral concept at best, it's plausible that during the 25 years following World War II non-commercial television reached it's highest levels of public consciousness via poor quality transmissions, didactic programming, and public appeals for funds. The perennial dichotomy between outright instruction and more general-interest cultural

programming may degenerate into one approach versus the other clouding a station's sense of mission and ability to successfully court its desired audience. This confusion is reflected in the licensees of non-commercial channels around the country: in some localities the licensee may be an educational institution or consortium; in other areas, the non-commercial channel may be licensed to the community. Merging these oft-diverse interest groups into a national system cohesive enough for interconnection, however occasional, was regarded by friends and skeptics alike as a herculean task.

There are at least three other key elements to the broader environment surrounding the emergence of "Sesame Street". One is the political-educational milieu in the U. S. at that time, particularly the interest in programs and innovations which might improve educational opportunities and performance for members of minority groups. This setting is analyzed in more detail in Chapter 3. Another important environmental element is that of non-comercial or educational television which we have chosen to treat in Section VII. Also, private foundations often provide "seed" money for innovative projects considered within their sphere of interest. In this case, the Carnegie Corporation with its long-established interest in education was the original donor to "Sesame Street," funding the period of gestation that preceeded pre-production planning. The Ford Foundation, with its long-standing tradition of generosity to non-commercial broadcasting, and the United States Office of Education became principal donors to the following planning, production, and evaluation phases.

IV. THE "INVENTING" (OR INITIATING) UNIT: THE CHILDREN'S TELEVISION WORKSHOP.

The Children's Television Workshop underwent metamorphosis from a collection of individuals into an organization. Its beginning is cloaked in anecdote. An after dinner conversation produced the consensus that existing U. S. television was failing to take advantage of the native abilities of young children to learn from the medium. The opinion proved to have a life of its own ... propelling the discussants into action to change what was considered the sorry state of affairs. The participants would already have been considered more well placed than most to at least air their opinions; Mrs. Joan Ganz Cooney was then a producer for non-commercial WNDT-TV in New York City, and Lloyd Morrisett was an executive of the Carnegie Corporation. (13) Still, neither one squarely represented any constituency that might be considered to have an interest in their opinion; to wit, neither the education nor broadcast establishments. Although both might be considered figures of the educational periphery, e.g., involved in providing services and concepts relating to education, and each had either taught in a classroom or studied pedagogy, neither has spent the bulk of his or her professional life within the educational establishment. Similarly, a large part of Mrs. Cooney's broadcast experience had been on the public relations, promotional, journalistic side, and her then-position as a producer of public affairs programming with a non-commercial station hardly equipped her to be part of the broadcasting establishment. What had happened, in effect, was that two motivated individuals representing a collage of tangentially-related experience but with real ties to seed money from private foundations arrived at a mutual opinion. Through professional contacts spanning the media and academic worlds, research ... of both a library and interview nature ... could be undertaken financed

initially by a private foundation (the Carnegie Corporation).

The transition from paper to action evolved through research proposing production and subsequent efforts to effectuate the proposal, involving consultations with outside experts and the ultimate staffing and funding of new entity to implement plans. Funding escalated along with the magnitude of the efforts, going from a Carnegie grant of unreported amount to WNDT so that Mrs. Cooney could take three months and mount a "feasibility study" ... to the $8 million 1968 budget for the Workshop (which by then had taken organizational shape) to produce 26 weeks of hour-long weekday television shows (130 episodes) to "teach" cognitive skills to children between the ages of 3 and 5. Monies were funneled through National Educational Television (NET), the grantee of record, which would, in turn, establish the Workshop. NET was the New York City based production house and distribution center for much of the programming seen on non-commercial stations around the country. It's relationship to the system's evolving organizational structure has changed over time, but it has always existed in conjunction with it. As the budget escalated, funding sources proliferated ... of necessity. Reportedly, $4 million was raised from the Carnegie and Ford Foundations alone, the remaining 50% coming from the federal government's Office of Education (OE). OE was the prime government funding agency, providing the lion's share of the federal monies. What OE did not provide was taken care of by top level agency officials who personally sought additional funds from a variety of federal agencies operating within the social and health spheres. By all accounts, the program in preparation was initially rejected by the commercial networks. This prompted yet another working relationship arrangement between the Workshop and non-commercial television entities, e.g., NET, for it looked as though it would have to

be the non-commercial stations to carry the program if it were to get any television exposure.*

The entity created to implement programming plans was the Children's Television Workshop (CTW), established as a private non-profit organization to produce television shows which would use the educative potential of the medium while entertaining its audience. Program design was carried out by CTW professional personnel. For that a staff of educationalists and broadcast production professionals was assembled. Qualified individuals who would operate in a spirit of collaboration were required. To that end a critical feedback loop was built into the organization. Indeed, a sense of working collaboration between the two camps, i.e., educators and broadcast production professionals, and ongoing feedback might be considered the guiding and distinctive principles of CTW. Mrs. Cooney, apparently, bore most of the recruitment burden. She was aided immeasurably by Morrisett's contacts throughout academia, her own recollections of production personnel, and the good will exhibited by some ranking television executives who directed her to experienced individuals currently uninvolved with commercial television productions.

The term educationalists for the pedagogic staff members is used advisedly. The individuals recruited were specialists, e.g., educational psychologists and researchers adept at thinking in terms of principle and methodology. They possessed the additional qualification of a willingness to work through the medium of television.

While the broadcast staffers were individuals experienced in commercial

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*It is not to be inferred that the commercial networks were inimical towards the Workshop or its goals, but rather that the concept was novel, the producers collectively untried, and the funding requirements substantial. In fact, mention has been made of the good will of the commercial networks as shown by the provision of promotional time and gifts of television receivers to equip neighborhood viewing centers. (9)

"kidvid" production, they were not culled from the animation companies that supplied cartoon fare. Instead, they came from the ranks of daily children's programs, reflecting the organizers' convinction that the mechanics of volume production must be understood and mastered before anything else could be attempted. (23)

A different kind of staffer was needed for post-production work. Conceptualized as the utilization component, post-production efforts centered around maximizing participation by the "disadvantaged" audience, and designing strategies to enhance the benefits of viewing. Perhaps it was more than coincidental that at the beginning utilization would require its own organizers within target communities, and a utilization staff was assembled by 1970 for the second broadcast season.

The generous budget of $8 million given CTW by its backers was allocated among departments in a fashion that has held constant over the years. Primacy was given production so that the finished product would look good, reflecting production values competitive with those of the commercial networks. Therefore, 70% of the funds were spent on production, with the resulting rule-of-thumb cost of $40,000 per hour of programming. The remaining 30% of the budget was spent unequally; 10% on distribution, and 20% on research and administration. (20a)

During the planning and production phases the Workshop functioned as it was meant to; the critical feedback loop was intact and well used. Operationally, the educationalists conducted research on children's viewing habits and preferences, as demonstrated by their attention to television programs. Cognitive goals and priorities were decided upon, much of the groundwork having been laid during a series of summer seminars attended by noted invitees from the worlds of academia and media. Production personnel then implemented the educational design through scripting and other production procedures. Completed segments were tested on sample

audiences with particular reference to attention-holding qualities; educationalists reported back to broadcasters on the success of various techniques and vignettes so that broadcasters could modify accordingly.

The cognitive aspect was not ignored. From the onset attention was given to how much, if any, learning was taking place; CTW was, after all, dedicated first and foremost to the educative potential of the television medium. This concern had two foci: 1) creation of program segments that held the audience's attention while instructing, and 2) measurement of learning gains. The first area of concern was worked out in the collaborative production process and subsequent audience testing. The second area of concern prompted the Workshop to call upon the services of the Educational Testing Service (ETS) of Princeton, New Jersey, to construct a research design and measurement instrument to be administered after one full season of broadcasting.* ETS personnel were involved with Workshop preparations even during the pre-production planning phase. (13, 15, 18) Nonetheless, it was an early decision to validate the cognitive intent of the program. This probably stemmed from CTW's avowed mission to combine educational planning with television capabilities, and input from funders so that their participation could hopefully be justified.

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*CTW's own researchers conducted "spot checks" during the course of the first broadcast year to make sure "Sesame Street" was on target. These were not as extensive as the ETS studies. (15)

V. THE INNOVATION: "SESAME STREET"

Monday, November 10, 1969: "Sesame Street," the premiere production of the Children's Television Workshop, debuts over approximately 200 television stations across the United States. The arrival was widely-trumpeted, unusual for a maiden effort of an untried production house. But then "Sesame Street" represented a programmatic innovation of wide application because of it's technological base.

"Sesame Street" was programmatically innovative in both conception and implementation. Conceptually designed to impart learning readiness skills to pre-school-aged children through production techniques commonly employed in television programming and commercial presentations (e.g., sponsorship messages), in implementation "Sesame Street" represented the merger of entertainment and educative principles much as CTW represented the merger of broadcast and pedagogic personnel in organizational terms. Additionally, the show had an affective dimension. Without pedantry, "Sesame Street" portrayed an inner-city residential setting inhabited by people and puppets of assorted ethnic backgrounds; by implication, they could get along. The characters and setting were intended to appeal to children in general, and also to provide some basis of identification for the subset target audience of predominately urban, "disadvantaged" youngsters. Production techniques employed ranged from interactions among the "live" residents of "Sesame Street" to filmed and animated inserts. A repertory company of "muppets," or hand puppets, portrayed an array of imaginative characters from a garbage-can dweller ("Oscar") to an insatiable "Cookie Monster". The street is also graced by a seven-foot canary ("Big Bird"). The production is clearly geared to children's tastes.

"Sesame Street" was either going to sink or swim on a broad scale; initial exposure was national in scope.* Of the approximately 200 stations that premiered the show, all but one were non-commercial outlets. Essentially CTW planners wanted the broadest possible coverage for their product -- given the limitations of the non-commercial system. To that end, CTW sought to use the interconnection only recently established for occasional use by non-commercial television so that "Sesame Street" could be simulcast nationally during the morning hours. To achieve this, Mrs. Cooney and Robert Davidson as representatives of CTW, personally toured the top 25 broadcast markets** speaking to educators and station operators to encourage clearances. Securing the agreement of educators was considered crucial. Some localities may have had a station committed to in-school instruction at 9:00 A.M., the time CTW was trying to have cleared for the show; scheduling turned out to be the biggest problem. (23) Of the 180 non-commercial stations in 1969, about 48% ... representing most of the larger markets ... cleared the show in the morning. (14) Subsequently, after the show had established its audience attractiveness, CTW allowed supplemental commercial distribution. In that case, local broadcast rights went for whatever the market would bear, which usually was minimal. (23) Land reports that 60% of the potential audience was blanketed for "Sesame Street" coverage in this way. Cooperating stations knew they would receive 26 weeks of programming. This was built into the 1968 funding arrangement, which budgeted $8 million (see p. 22) for start-up and promotion costs plus six months worth of production. Had "Sesame Street" gone the route of the commercial networks, it may be

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*Although there were 5 isolated "sneak previews" during summer, 1969; a UHF station in Philadelphia sent the program into "60 selected homes," and in New York City some day care center attendees also received the feeds. (15)

**At least. Davidson later estimated 40 market visits were made altogether, the additions resulting from requests of stations in smaller areas. By visiting a minimum of the top 25 markets when seeking clearances, most of the target audience would be reached. (14)

surmised that the show would not have been guaranteed a year's outing; commercial time is simply too valuable to reinvest in a program property that failed to initially draw or eventually woo a goodly share of its desired audience. By going non-commercial, a system unaccustomed to measurable ratings, CTW planners could initially disclaim any desire or need to become overly concerned with gross audience measurement.

The attractiveness of "Sesame Street" to cooperating stations may have been grounded in factors other than the purely broadcast economic. Non-commercial outlets, in particular, may have seen it as a chance to perform a public service ... and win much needed friends in the bargain. The need for nursery, or pre-school, education had enjoyed an upsurge of friendly public interest: Projects such as "Head Start," designed for many of the same reasons as "Sesame Street" but on an in-school basis, not only concentrated attention on nursery education, its availability, and clientele, but also held it accountable in both cost and cognitive terms. While "Sesame Street" did not claim to be a comprehensive nursery program, it's reliance upon television could result in substantially lower cost-per-client figures than any other early education option. Data compiled by the Education Commission of the States reflecting 1970 costs reveals per-pupil costs of approximately $1500 for in-school programs versus approximately $1.00 for televised instruction (based on "Sesame Street" cost). Both figures represent annual per-student costs and either extreme of the cost continuum. A middle-range example would be the pre-school program constructed by the Appalachian Educational Laboratory which combined televised instruction for pre-schoolers with home visitation and a mobile classroom for reinforcement. The annual cost-per-child for the AEL program was cited as $242.15. "Sesame Street" cost data does

reflect the add-on expenses of the community education, or utilization, component; (23) in mounting an outreach effort CTW has been careful to make heavy use of volunteers or occasionally, workers paid by another source, as in the case of the Neighborhood Youth Corps experiment. (20a, 23)

In a sense, it is ironic that non-commercial television should become the prime outlet for "Sesame Street." Traditionally, it has attracted an audience skewed in favor of the middle and upper socio-economic classes, hardly the subset target audience for CTW's show. The fact that "Sesame Street" was successful, and attracted substantial ratings in both middle-class and inner-city neibhborhoods, attests to resourceful intervention to induce the desired change in viewing habits and promote exposure to the innovation.

VI. TECHNIQUES OF CHANGE: FACTORS AND PROCEDURES AFFECTING ADOPTION/USE. SKILLFULLY MARHSALLING PUBLIC CONSCIOUSNESS BEHIND THE INNOVATION

In large part, "Sesame Street" succeeded because it was an idea whose time had come. Capitalizing upon the effect of "Great Society" programs and legislation, the former often reliant upon community organization and the latter instrumental in raising public consciousness vis a vis many social issues, the Children's Television Workshop mixed the glamour of television with the concern for early cognitive intervention and cloaked the bundle in palatable dosages of publicity interspersed with cost-effectiveness ratios. This was coupled with a creeping sense of national anomie which contributed by promoting a public search for alternatives, whether for alternate educational or broadcasting systems. Altogether a heady brew, but one that apparently worked.

Policies formulated by the Children's Television Workshop itself to promote acceptance of its product included the establishment of a Promotion and Utilization Department and a Research and Evaluation Department. Both were divisions with double names and double missions. Promotion and Utilization was to acquaint the public and target audience with the show ... a crucially important task at the beginning ... and to act as an out-reach arm into target-audience communities once the show was aired. This department has since been divided along task lines. Research and Evaluation was to engage in formative (pre-broadcast) research and to act upon the findings of summative (follow-up; post-broadcast) research; the latter was contracted to the Educational Testing Service. Establishment of this department internalized a research function within the organization. The arrangement may have helped to legitimize research internally; externally, ties were eventually formed with Harvard University to establish the Center for Research in Children's Television ... a move to legitimize this kind

of activity on a wider scale thru continued study of youngster's ability to learn from visual media. (15) Always, research findings were made available for dissemination, in keeping with the experimental nature of the Workshop as perceived by its originators.

In practical terms, this meant a crucial role for the Promotion and Utilization Department in particular. Its job was to reorient the target population's viewing habits so that the show would be sampled, at least, and then to encourage continued meaningful participation. The Department head was an experienced public information man who had held a similar position with the Peace Corps: CTW hired him, arranged an association with a New York public relations firm, and stationed him within CTW to give full-time attention to promotional matters. (23) Promotional techniques employed included sound trucks, mailings enclosed in utility bills, and free plugs in a variety of media; indeed, the promotional budget was not large, $600,000, and benefitted by the free plugs given the project because of its novelty. Usually, these were in media attracting the white middle-class audience. While attempts were made to reach parents of all pre-schoolers, methods for reaching the urban subset audience in particular were concentrated upon. Publicity for the premiere season was carried out by grants to stations in 10 cities, and through contacts with an array of national organizations representing a defined "constituency," e.g., The National Council of Negro Women, The Boy Scouts. Realizing the importance of local contacts, the mechanics of community promotion were essentially left to local discretion. The more successful strategies were those employing media of the subset audience itself, e.g., black radio stations, and extensive person-to-person contacts with community members. Mixed results produced realization of the need for some general guidelines and specially-trained CTW staffers operating from various localities they were representative of. (14)

To that end, the Utilization component expanded in 1970 by hiring local representatives, eventually called field coordinators, for out-reach activities in 12 cities. The experienced community workers selected assembled in October of that year for the first such training workshop conducted by CTW. Entrusted with many tasks, the main charges were to establish as many viewing outlets as possible ... whether in day care centers, nursery schools, or groups formed for that express purpose --- and to acquaint as many adults as possible with helpful ways of reinforcing the televised material. That summer (1970), the Utilization Department had established another precedent by its use of Neighborhood Youth Corps participants as teachers of area children "enrolled" in "Sesame Street" viewing groups. Both programs have since expanded. (9, 14, 20a)

There were a variety of other factors which appear to be crucial to the success of the innovation. Some of these emerge from Polsky's informative analysis (18). Factors include:

1. Successful blending of broadcasters and educators with sufficient funds to produce television programs that could compete with commercial fare for audiences. Unlike some other countries where the educational program may be the only thing on television during the school hours, "Sesame Street" had to compete with an assortment of soap operas, quiz shows, old movies and cartoons. It did so because its budget was of the order of magnitude of commercial TV (or $40,000 per hour) and because it did not fall back on the conventional ETV pattern of small budgets and talking faces.

2. Going around the schools instead of attacking them head on. Innovation in education is a difficult proposition. By reaching children in their homes and not directly conflicting with prerogatives and routines of teachers, the innovation was able to begin to take hold in schools.

The follow-on show, the Electric Company which, in contrast to "Sesame Street", was geared towards school-age viewers, was viewed in 1971-72 in 23% of the schools in the U. S.*

3. The essentially "conservative" natúre of the innovation as identified by Polsky -- conservative in the sense that readily measured cognitive goals were emphasized and less readily measured affective objectives were downplayed.

4. The existence of a large scale distribution system, namely public television, which enabled the program to be rapidly distributed throughout the U. S. This was in marked contrast to previous educational TV programming dissemination.

5. The marshalling of sufficient funds for a sufficient period of time to get the innovation off the ground. Both foundations and the federal government played important roles. The roles of Harold Howe and Louis Hausman of the Office of Education in assembling the government contributions, as documented by Polsky, are worth noting.

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*Communication with CTW Secretary Robert Davidson indicates that their corporate thinking was not dedicated to avoiding either contact or confrontation with the schools. CTW's position was that they had a product for pre-school education, a pedagogic specialty usually not handled by operating school systems. "Electric Company" marked no deviation, intended as it was for supplemental at home reading instruction. While acknowledging CTW's thinking on this matter, the authors respectfully point out that regardless of motivation, the end result was that distribution and "marketing" of the innovation was hardly dependent upon prior approval of teachers and did in fact become utilized in schools. (23) Davidson also notes that the high in-school penetration rate for the program was a surprise to the producers. (23) It should be pointed out, however, that in-school time was cleared over the non-commercial interconnection for airing the show, and the ETS evaluation was designed to include the variable of at-home or an in-school viewing pattern. The instructive capabilities of the program in either setting have been investigated by follow-up research. (2c)

VII. THE ADOPTERS: THE NON-COMMERCIAL BROADCASTING ESTABLISHMENT

The quasi-public non-commercial broadcasting establishment, local stations and entities of national scope, became the adopters of CTW's innovative television presentation since "Sesame Street's" primary broadcast outlets were non-commercial stations. This occurrence was not so much the result of a single, over-riding decision as it was the product of a continuing process of related decisions affecting the structure of American non-commercial broadcasting in general.

Known synonomously to the general public as instructional TV (ITV), educational TV (ETV), or public TV (PTV), each phrase roughly parallels a development in the evolving saga of non-commercial broadcasting in the United States. A capsulized history shows the non-commercial system developed consistently more slowly than the commercial broadcasting structure. Some of the pioneer radio stations were licensed to universities and other educational institutions, for even then the instructional capabilities of the medium were recognized, but they were often edged out in the scramble for spectrum space that ensued. In spite of repeated attempts to legislate reserved spectrum space for educational stations, definite action of that sort was not taken until 1952, when the "freeze" on television channel allocations was lifted by the FCC and 224 channels,* in both frequency bands, were reserved for non-commercial, e.g., educational, licensees. The television broadcast boom that followed was tangential to non-commercial broadcasting. Educational channels took to the air slowly, often to a less-desirable UHF berth, and reception and financial problems inevitably followed.

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*The precise number of reserved allocations varies with the source. Nonetheless, the FCC has since expanded the channel allocation for educational use.

By the mid-1960's about one hundred ETV stations were in operation airing local programming generally for in-school instructional use (ITV). To secure non-local programming the Ford Foundation had established the precursor to National Educational Television (NET) in 1954. Originally, NET acted as a duplicating organization for programs produced by the various non-commercial stations and also acted as distributor; eventually, NET branched into program production. Still there was no network, or simultaneous interconnection, the long-line costs being prohibitive for the impecunious system.

1967 marked the turning point for educational television, as demonstrated by a Carnegie Commission suggestion to rechristen it public television (PTV). During that year both the Ford Foundation and the Carnegie Commission on Educational Television made public statements that were to prove germinal; the Ford Foundation, a longtime benefactor, also funded the first real-time interconnection. Late 1967 also marked the passage of the Public Broadcasting Act, laying the groundwork for federal monies to partially support a non-commercial system. The Ford Foundation had responded to an FCC solicitation regarding domestic satellite communications. The Foundation suggested a dedicated television satellite with the interconnection cost savings realized by the commercial networks used to underwrite free interconnection for the non-commercial stations. (10) The Carnegie Commission addressed itself to the issue of appealing utilization of prime evening broadcast time on educational channels, and came to the conclusion that meaningful, general-interest programming devoid of advertising would provide viewer enticement. (13) The proximity of the proposals, and eventually the legislation, jolted those inside and outside non-commercial broadcasting into thinking of it as ... at least ... a dark horse contender for competitive status.

Much restructuring needed to be done. Local stations remained the bedrock of the system, but a national superstructure was needed. This was partially accomplished by the 1967 Act which established the Corporation for Public Broadcasting (CPB) to channel funds to different entities serving as production centers. Local stations were free to compete for funds with programming proposals, and encouraged to continue locally-originated programming, but to ensure a built-in measure of decentralization (seen as being in sharp contrast to the commercial system) seven entities were designated as production centers. The majority were stations with strong track records for serving their localities, but some non-station-aligned centers were included. During the late 1960's, NET was one of the latter centers. By allowing the new CTW to come under its rubric, NET provided administrative savings and expertise ... particularly legal ... to the new entity. (6,13,18) As of this writing (1974-1975), NET has been incorporated into the New York City non-commercial channel, and CTW remains a non-station-aligned production house for the non-commercial system.

By 1970, the distribution function of NET was switched to a new creation, the Public Broadcasting Service (PBS), charged with maintaining and servicing the interconnection among public stations. By the fall of 1970, CPB/PBS was ready with a prime-time evening programming feed to all participating stations which could then offer an alternative to commercial programming during the prime viewing hours. A year earlier, CTW had paved the way during the daytime hours by arranging a sufficient number of station clearances for "Sesame Street," a task considered most diffifult since local educators were being asked to relinquish in-school instructional time for non-enrolled students to participate in a curriculum over which there was no local input. Yet CTW planners had been able to accomplish this plus clearances for an afternoon, after-school daily playback.

This accomplishment lies at the heart of the impact of the innovation on the non-commercial broadcasting adopters, for there existed a symbiotic relationship between "Sesame Street" and the Corporation for Public Broadcasting. The Cooney-Davidson tour of broadcasting markets to arrange clearances for a morning feed of "Sesame Street" helped to weld the national superstructure and individual stations together prior to the routinization of interconnection. The ultimate success of the program, commonly regarded as public broadcasting's first "hit," bestowed status and public recognition on the long-ignored non-commercial system. Top management at CPB, and eventually PBS, was new in its position; heading a loosely-knit organization that looked as though it were "going places" surely must have helped them ease into their new positions. Although the system-wide and public acceptance and success of "Sesame Street" may not have been directly related to their managerial tenure, the cooperation exhibited by John White, President of NET, bears mention. Polsky's account(18) seems to indicate that Mr. White entered into an agreement with the newly-formed CTW that was remarkable for its latitude; CTW was allowed to function as a semi-autonomous entity and provisions were made for separation, should that become desired (they were enacted the following year). By allowing CTW under its umbrella, NET provided true help by making its legal, and station relations departments available without smothering the independence of the new organization.

Finally, the popular and intra-system success of "Sesame Street" seems clearly instrumental in paving the way for acceptance of the next CTW production, "Electric Company." Designed for the slow reader in the primary grades, "Electric Company" debuted in the fall of 1971 and won kudos while achieving a high penetration for instructional use during school hours. Like its predecessor, "Electric Company" is played back

during after-school hours for at-home reinforcement of curriculum. Land (14) comments extensively on the relative ease of placing this kind of program on the interconnection; at the base of his thinking is the contention that it is easier to clear time for overtly instructional programming, schools instinctively responding to educational materials. However, this consideration may be debated. Once again, individual stations and local educators were asked to relinquish time for a program targeted for enrolled students which lacked local curriculum input. Although the show was viewed as supplementary to methods used by individual school districts, surely the scheduling placement and high in-school use of "Electric Company" flowed from the recent success and high public praise and awareness earned by "Sesame Street." Getting cooperation of that magnitude with relative ease usually implies a congenial precedent.

Yet another spin-off of the "Sesame Street" experience was the search for other audiences to which the same format could be applied. The public broadcasting system was placed squarely in the public eye as the innovative broadcasting system; it could teach effectively and entertain. The quest to build upon this newfound public image was uncorked. Analysis of the "Sesame Street" format indicated the following: 1) a well understood target audience due to extensive pre-broadcast research, 2) use of appropriate entertainment and curricular techniques to reach the desired audience, and 3) community outreach activities to reinforce curricular gains and ensure continued participation. Although other factors contributed, such as the careful attention to promotion which marked another first for non-commercial broadcasting, post "Sesame Street" thinking held that this procedure could be replicated for other audiences with different instructional problems. The abortive Project STRIVE of ALPS is an example. The Adult Learning Program Service (ALPS) of the CPB was created and intended to premiere with Project STRIVE, a nation-wide evening program

to equip viewers lacking a high school diploma with the requisite skills to effectively cope with daily existence in a highly-industrialized society. STRIVE did not intend to prepare its audience for the high school equilavency examination; rather, the emphasis was to be upon basic computation and language arts skills so that the individual could figure his bank balance or write a letter to his banker with ease. STRIVE planners hoped that viewers would find participation so pleasurable that they would be inspired to seek out local programs preparing them for the high school equivalency test. 1972 budgetary exigencies of the Corporation for Public Broadcasting forced postponement and eventual cancellation of this program.(20b) Current activities within the non-commercial system seem to indicate renewed interest in programming for this audience and in education in general. (19, 24)

VIII. THE USERS: PRE-SCHOOLERS AND THEIR FAMILIES

The users of the cognitive programming provided by the Children's Television Workshop were primarily viewers between the ages of 3 and 5, and secondarily their mothers and siblings. A subset of this target audience would be the "disadvantaged" pre-school population, or those urban and rural youngsters largely unreached by nursery education programs. These children would be asked to compete upon school entrance with other youngsters who had already acquired a more substantial cognitive preparation for reading and other academic tasks. Promotional tasks were based upon viewer research which indicated that young children were a particularly captive audience during the day while at home with their mothers, and that this pattern continued into the late afternoon when older children returned from school. However, the youngest children had the least control over the television dial, so extensive efforts were made to acquaint both mothers and older children with "Sesame Street" so that pre-school viewers could be catered to.

Literature about CTW is replete with the figure of 12 million pre-schoolers for the prospective audience. Data from the United States Office of Education for 1970 indicated that approximately one-third of Americans between ages of 3 and 5 were attending some kind of formal nursery education program; 4.1 million youngsters from a population base of almost 11 million. Additionally, children living in metropolitan settings had a better chance of being served than those living in rural areas, with most minority group children residing in urban areas. Enrollment in pre-primary education programs had been incrementally rising since 1964 when the government began compiling such statistics; included in the expansion were younger children, 3 and 4 years old, and minority group youngsters ... benefitting

from programs to increase publicly-supported early education programs. (20a) Whatever the data source, one thing is clear: not all eligible children have access to in-school early education programs, but better than 95% of American households have television sets. (15) The audience is there, probably positioned before the set.

A former FCC Commissioner has widely exhorted American viewers to "talk back to their television sets,"* yet open-circuit television is generally regarded as a public and passive medium. The reliance of CTW on a public medium for distribution of its product meant that it was neither possible nor desirable to restrict viewership, and there was no way of discouraging the better prepared child from watching. Extensive efforts were made to make sure the subset target audience was viewing (see Section VI). Despite these attempts, CTW has been criticised for perpetuating the cognitive preparatory differential among pre-schoolers by using a public distribution medium that failed to distinguish among those receiving the product.

Although CTW is carefully structured to allow for and encourage feedback between the two professional camps included within it, with some allowance for audience input ... both features are new twists that are somewhat out of keeping with the passivity supposedly built into over-the-air broadcasting. Theoretically, broadcasting functions as does a democracy because the public determines the survival of programs by either watching in sufficient numbers or failing to view. Undoubtedly, ratings are one clear indication of sentiment and a form of feedback. Viewers may write to performers, producers, or networks; whether this is systemmatic or scientific sampling, or if it provides any substantive input, remains open to debate. It is perhaps safe to say that direct viewer impact on production decisions remains

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*Nicholas Johnson, How to Talk Back to Your Television Set. Boston: Little Brown and Co., 1970.

elusive. CTW field coordinators and relations with local stations are perhaps the closest approximations to parental feedback given the structure of the distribution system in general. Formative research activities, or those engaged in to test material on an audience prior to general viewing, are held by Davidson to be an important audience feedback mechanism. (23)

IX. IMPACT OF THE INNOVATION: CONSEQUENCES AND EVALUATION

EVALUATION: MEASURES OF VIEWERSHIP AND COGNITIVE GAINS

"Sesame Street's" effectiveness could be measured in two ways: 1) by designing an instrument to test for cognitive gains by the viewers, and 2) by using measurement techniques to gauge audience size and target audience tune-in. Both approaches required some refinement since a project of this nature with this target audience had not been tried previously. The first measure was designed by the Educational Testing Service (ETS) of Princeton, New Jersey, the recognized leader in the field of educational testing in the United States. ETS personnel worked with the CTW organization almost from its inception so that each party would have a clear understanding of what the other was trying to accomplish; this facilitated curricular planning and the construction of relevant measurement devices. The second measure was carried out by a number of agencies. The marketing research firm of A. C. Nielsen produces the audience measurements, ratings, that are the standard for American broadcasting. ARB ratings are also employed. However, because of the lower socio-economic strata of "Sesame Street's" subset target audience, there was concern among CTW planners that the Nielsen ratings would not be appropriately weighted to accurately reflect the show's penetration of these viewing groups. The legacy during the late 1960's of miniscule audiences attracted by non-commercial broadcasting was also felt to mandate specially commissioned studies and to free CTW executives from the burden of playing the "rating game," although audience size remains a cost determinant whether the program is distributed commercially or non-commercially.* The ultimate success of the show produced a change in thinking, and Nielsen numbers are now used by CTW as a determinant of viewership.

*That is because the cost-per-viewer will decrease as audience size increases; thus a total cost figure can more easily be justified when prorated over a larger audience.

THE ETS STUDIES

Essentially, the ETS study conducted after the first broadcast year of "Sesame Street" set out to determine if the show did what it was designed to do. This amounted to concentration on cognitive progress in some instructional areas, with little attention if any, paid to affective or emotional growth of the viewers. Admittedly, the latter qualities are the more difficult, if not impossible, to measure. Lesser (15) notes that ETS personnel did attempt to determine what, if any, unintended effects might have resulted from "Sesame Street"; an example would be a positive attitude towards learning. Structure of the study was for pre-testing prior to broadcast followed by post-testing after the entire season. Population samples included children in the 3 to 5 age range living in urban, suburban, and rural communities representing lower and middle socio-economic groups and caucasian and minority (both racial and language group) youngsters. The original design called for division of the sample into experimental, e.g., viewing, and control, e.g., non-viewing, groups. Testing was administered by specially-trained ETS personnel recruited from the different population elements within the sample; this approach was retrospectively considered very valuable when dealing with urban minority communities. (15)

Findings of a more general nature were that regular viewers gained more than irregular viewers, irrespective of pre-test scores, socio-economic status, group membership, or residence. Should the child's mother have habitually viewed with him and spoken with him about the program after it went off the air, learning was helped. Learning would take place whether the child viewed at home or in an organizational setting; neither environment was substantially more beneficial. Specifically, cognitive areas given more emphasis on the program were those in which

viewers registered the greatest gains. Interestingly, progress in language (e.g., letter) skills was faster than with number skills of corresponding complexity. Results of the 1970 ETS study, (2a) and those done in subsequent years, have been publicly disseminated. Subsequent ETS studies have shown that viewers are able to retain their knowledge, build upon it ... as reflected by the updated televised curriculum, and do not "turn off" with formal educational programs ... either when entering kindergarten or Head Start programs.

Although the findings as related here are highly capsulized, data from all ETS studies would seem to indicate that "Sesame Street" accomplished most of what it set out to do. Polsky (18) attributes this, in part, to the "conservative" nature of the show; goals were consistently honed to manageable proportions representing realistic estimates of what could be hoped to be accomplished. CTW planners have related that there were some surprises. Children younger than 3 became avid viewers and learners, not to mention the general audience appeal the program turned out to have.

In the ensuing years, "Sesame Street" foreign-language versions have been produced in Mexico, Brazil, and Germany. Follow-up studies of foreign audiences have corroborated the general findings of ETS regarding cognitive impact. Specifically, Israeli researcher Gavriel Salomon found that children from lower socio-economic groups could learn "abstract" skills from the media (e.g., the ability displayed by Israeli children to pick out the crucial elements in a situation to enable problem solving), especially when their mothers watched with them. (15)

Hosannas were sprinkled with brickbats. Lesser details those university-based researchers who faulted the production for perpetuating the cognitive gap between "advantaged" and "disadvantaged" viewers. Lesser, himself intimately connected with the Children's Television Workshop, counters by

claiming that such studies begin with the assumption that nursery education for "disadvantaged" viewer must have a compensatory, or deficit-reducing, basis; this, he stoutly maintains, is contrary to the initial and working premise of CTW. (15) Other critiques have come from those who question the efficacy of an $8 million budget to teach young children to recite the alphabet. (16) Undoubtedly, proponents would reply that the program aimed somewhat higher. Attention was given to basic skills considered requisite for more demanding intellectual tasks, e.g., relational and causal concepts. Analysis of first-year program content would seem to indicate that most stress was placed on teaching more elemental abilities.*

Fall, 1974, marked the beginning of "Sesame Street's" sixth season. Curriculum has been amended to build on the viewer and summative data that has been assembled since the show first aired. Debate over the relative merits and demerits of the program continues ... sometimes hotly, other times desultorily. To date, the backers, the planners, the public, and the viewers seem basically happy with the innovation.

AUDIENCE MEASUREMENT STUDIES

All audience measurement studies agreed that "Sesame Street" initially pulled a sizeable audience; furthermore, the program was drawing well with its target audience. Samplings conducted during the course of the 1969-'70 broadcast season indicated that audience size increased as the year progressed. This has been a trend during ensuing seasons; the number of stations carrying the program, total number of viewers, and viewers among the target audience have all continued to increase.

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*This is by no means the complete gamut of criticisms leveled at the show; the range is from the philosophical (abridgement of children's rights by adults determining curriculum) to the utilitarian (why prepare for school entrance?). (15)

"Sesame Street" planners may perhaps retrospectively be considered conservative in their pre-broadcast guesstimates of audience size. Lesser relates that in 1969 CTW assumed that its reliance on the non-commercial system would maximally enable it to reach 60% of American households. This assumption was based on the UHF frequency of many public stations, and on the relatively limited geographic distribution of non-commercial stations ... being comparatively scarce in rural areas and small towns. Keeping in mind the CTW total audience assumption of 12 million pre-schoolers, it was further assumed that with the constricted nature of the non-commercial distribution system the maximum potential audience would be 8 million.

Two weeks after "Sesame Street's" debut, the routine Nielsen survey indicated an audience of 1,580,000 households. To translate this figure into the number of viewers, it was predicated that 90% of the households included children of pre-school age, and that there would be a 25% chance of more than one youngster viewing per set. Therefore, this was taken to mean that "Sesame Street" had attracted between 3.5 to 4 million viewers. As the season progressed, tuned-in households were to climb to slightly better than 3 million. It was felt that 50% of inner-city youngsters in day care centers or other nursery settings were also watching. (15)

Special audience surveys consigned to the research firm of Daniel Yankelovich and Associates were intended to measure subset audience size, specifically core city youngsters. Sampling the cities of New York, Washington D.C., Philadelphia, and Chicago, representing varying dosages of pre-broadcast promotion and a mix of UHF/VHF outlets, Yankelovich reported a range from 50 to 91% of those interviewed as being regular viewers. Total penetration percentages were not as high; here the range was from 32 to 88% of families polled having watched "Sesame Street" (including occasional viewers). Subsequent

Yankelovich surveys cited by Lesser reveal continued high penetration rates in these core city areas (excluding Philadelphia).(15)

CONSEQUENCES

In addition to the measurement devices used to determine and evaluate viewership and learning gains, other ... more indirect ... consequences have been attributed to the "Sesame Street" innovation. Most have been alluded to previously, but bear elaboration at this point. Spin-offs include the new stature accorded non-commercial broadcasting by the general public, the quest to replicate the innovations of "Sesame Street," the relative ease of placing CTW's next presentation on the interconnection during school hours, and changes in children's programming distributed by the commercial networks. These consequences are less susceptible to the measurement techniques used to gauge audience levels and cognition gains; yet they are real and thus deserve mention.

The first two consequences cited may be summarized by referring to the upsurge of interest in public television. "Sesame Street" alone was not totally responsible. Programming imported from the BBC during the 1969-70 broadcast year, the well received serialization of "The Forsythe Saga," helped to win noteworthy audiences for the non-commercial system. Other factors impinged; the Public Broadcasting Act of 1967 and the increasing willingness of Americans to look for alternatives that was manifest in many diverse ways, also played a part. Yet the success of "Sesame Street" reinforced the notion of using television for educative purposes, a point not to be overlooked when trying to merge the often-diverse interests of funders, station managers, educators, and general public. Additionally, "Sesame Street" could be analysed and broken down into component parts, giving hope that contributing elements would succumb to transferability and the programming process could be replicated for other audiences. The

attempt at a project the scope of Project STRIVE of ALPS (see Section VII), although abortive, has not been abandoned. In 1974, the Advisory Committee of National Organizations (ACNO) of the Corporation of Public Broadcasting undertook a study to help determine the Corporation's future role in education. ACNO task-forces concentrated on four areas; formal post-secondary education, early childhood education, elementary-secondary education and adult education. Their report was issued in 1975. (24) In 1974-1975, a bill was pending before Congress to provide long-term (5 year) funding for public broadcasting at levels appreciably higher than in the past. Although this would seem to indicate that prospects for future funding of educational television are good, the extent to which the overall financial climate for new innovative public sector activity will remain favorable throughout the 1970's remains to be seen. Furthermore, the question of sustaining on a long-term basis something that was heavily supported during its experimental stage, such as "Sesame Street" must be addressed. Right now, Sesame Street ranks high on the list of public television shows chosen for support by the newest mechanism for public television program selection, the Station Program Cooperative.

CTW's follow-up presentation "The Electric Company" first aired in the fall of 1971 over the public broadcasting interconnection during school hours with replays scheduled for out-of-school hours.* By this time the producers had established a successful track record, and clearances must not have been too difficult to attain. Once again, local educators were being asked to relinquish time for curriculum over which they had no

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*See Footnote on page 33.

control. ETS was called in to mount an evaluation after the first year of broadcasting, and reported that "The Electric Company" possessed instructional properties for slow and beginning readers.(2c)

The symbiotic relationship between "Sesame Street" and public broadcasting has previously been detailed (see Section VII). The relationship between "Sesame Street" and commercial broadcasting has yet to be explored. The educative properties of "Sesame Street" were publicly lauded in sharp contrast to the mindless children's programming aired by the commercial networks. By the turn of the decade, grassroots interest groups such as Action for Children's Television (ACT) were gaining exposure for their views of child exploitation by the commercial networks. Both factors produced some changes within the commercial establishment. Vice presidencies in charge of children's programming were created at the networks for the purpose of upgrading the product. New programs began to appear intermingled among the cartoon fare and series repeats scattered throughout the weekend mornings and after-school hours. Designed to be expansionary rather than pedantic, the new shows were targeted for specific age groups and did not exhibit signs of constricted production budgets. Also, minutes of informative programming began to appear in place of some commercials.

Skeptics have considered the changes cosmetic, pointing out that in a system where time is money all new programming ultimately competes according to the standards of ratings, profitability, or at least marginality. Substantive changes, such as a reduction or outright abandonment of commercial messages, cannot be expected in such an atmosphere. The debate continues, highlighted by occasional hearings before the FCC.* Advertising on children's programs tends to be concentrated in a few companies;

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*In the fall of 1974, the FCC issued guidelines for broadcasters regarding children's programming. Chief among them is the reduction in allowable time for commercials. The guidelines have provoked dissatisfied responses, making the controversy far from over.(4)

modification of their advertising approach is being tried, a current avenue being pressure on the Federal Trade Commission to investigate spurious or misleading commercial claims. Whether notable change will result is uncertain. However, it seems safe to say that since the propitious confluence of factors in the late 1960's, the "problem" of American children's television has been undergoing a steady scrutiny that shows no signs of abatement.

X. SUMMARY ANALYSIS

The example of cognitive skill instruction for children aged 3 to 5 offered by the United States television program "Sesame Street" is a curious admixture of strategies and processes which may be understood within the framework of innovation in education. Emanating from a central planning and development center (the Children's Television Workshop) and partially reliant on federal political-administrative strategies including the reallocation of funds for the recently-prioritized early childhood education subsector, "Sesame Street" was adopted on a national scale, and ... curiously ... circumvented the usual adopters of educational innovation, the teachers, in favor of the students themselves. This process was possible because broadcast over non-commercial public television sent the program directly into the homes of its pre-school aged audience. Innovation planners augmented these policies by involving individual station operators and parents in an effort to obtain clearances and target audience participation, respectively. By doing so, they were striving for grass roots acceptance so that the innovation would not be thwarted by the indifference of either its intended audience or potential adopters (the non-commercial stations asked to carry the product). CTW executives employed the empirical-rational approach with individual station operators and local educational administrators during their pre-broadcast tour of the most populous broadcast markets to assure telecast during the desired morning time period. By mounting an extensive outreach campaign into subset target audience communities, a normative-re-educative strategy was used to enlist the help of community adults in reinforcing the televised material.

The nucleus of this grand design was those individuals who conceived of and developed the innovative television program. Indeed, the "Sesame Street" experience reveals the cruciality of the entrepreneurial element in fostering change, as exemplified by the roles played by Joan Ganz Cooney and Lloyd Morrisett. No other variable had as much influence on the development of the innovation; neither government nor private foundation funders, the limitations of the technology or the adopters, nor the users were given an opportunity to guide or misguide the program during its gestation period. That statement is made with appropriate qualifications; there was input from funders, both government and private, during the developmental period. In fact, in this instance, a considerable amount of initiative and entrepreneurship was demonstrated by a private foundation official who seems to have, because of his strong interest and belief in the project, gone well above and beyond the normal role of beneficent "grantor." However, those who originally conceptualized the idea that was to take form as "Sesame Street" did not relinquish control; rather they learned to distinguish among advice, separating the good from the mediocre and bad, and proceded to meld the entirety into a workable configuration. This interpretation is not without proponents, notably Lesser (15) and to a certain extent, Polsky. (18)

With financial support coming from a number of federal agencies channeled through one grantor of convenience, a number of private foundations with the Ford Foundation and Carengie Corporation preeminent, and the creation of a new organization to implement programmatic design but existing within the complex infrastructure of the non-commercial broadcasting system, the entrepreneurs took many steps to insure that the transition from idea to product would not be diluted by the many external factors which could be

brought to bear upon it. However, the innovators were undoubtedly aided by "luck," or the fortuitous combination of individuals and circumstances. In this case, luck was with Cooney and Morrisett because of the national outlook during the 1960's, and their success in approaching individuals in a position to take helpful action.

A good example is offered by their experience in obtaining the financial and moral support of the federal government. It was during the latter 1960's that the innovators approached the federal Office of Education (OE) for funds for a television program to teach school readiness skills. This was a time replete with public reaffirmation of the goals of a "Great Society" in which social problems, including educational inequities, would be eliminated. Public declarations had been backed by legislation, e.g., the Elementary and Secondary Education Act of 1965. Funding to implement the stated goals of the law was usually distributed through agencies operating on state or regional levels. In approaching federal officials, Cooney and Morrisett pointed out that by using television for distribution, children all over the country previously unreached by nursery education could be affected. The subset target clientele was considered to be core city and rural youngsters heavily drawn from lower socio-economic strata, and racial and language minority groups. This approach appealed to OE officials, who determined that legal means existed for central funding. Acting upon this, they proceeded to solicit monies from various agencies that could be construed as having an interest in this kind of program. Decisive action of this sort, permitting funding from a central source, spared the entrepreneurs the difficulty of negotiations with 50 state departments of education and myriad intermediate regional and local school districts.

Otherwise, the role played by government was indirect in nature, essentially one of nurturing a climate which proved receptive to the innovation. In addition to the favorable climate regarding help to education, there existed ongoing federal efforts to expand and upgrade the non-commercial, or public, television system. In 1962, Congress had taken an interest in the growth of the public system by appropriating funds for the construction of new stations or for improvement of existing ones. New stations took to the air expanding the nation-wide coverage of the non-commercial system. By 1967 came the passage of the Public Broadcasting Act, which made federal funds available for partial support of the non-commercial system while creating a new national superstructure for it. These developments were to intersect with the formative period of the innovation, since the existence of a public system provided the necessary distribution outlets for the program. Limitations of this coverage, such as the lack of routine interconnection among stations for simulcasting, were also to affect the implementation strategies used by the innovators.

Finally, entrepreneurial enterprise is also apparent in the organization created to implement program design. Key individuals took care to shield staffers from pressures which might have been exerted by backers, and to create the Children's Television Workshop as a private, non-profit organization in an atmosphere of institutional latitude which would allow for future growth. When soliciting funds, the organizers made every effort to secure as many backers as possible so that no one outside voice would have over-riding authority. Although most of the funding came from a few sources, the top level of CTW officials retained responsibility for communications with contributors in an effort to free other staffers so they could concentrate exclusively on their professional

roles considered so vital to the success of the program. Organizationally, CTW was originated as a semi-autonomous body within the public broadcasting infrastructure. Lines of authority between Workshop officials and executives of other system entities were carefully drawn without creating a parent organization. Room was left for rearrangement as future needs might dictate. In that way it was hoped that the new organization could draw upon the conveniences of established structures without being smothered by executive layers, or constricted if continued development mandated other arrangements.

What are the lessons concerning innovation in education to be learned from "Sesame Street"? Essentially, that the congenial combination of circumstances will do much towards propelling and aiding individual initiative. With a couple of exceptions, the role played by government was passive and consisted of creating the proper climate for a project of this nature to develop. The exceptions center within the top ranks of the Office of Education, where some crucial decisions were made and acted upon. One was the ability to secure funding at the federal level and channel it through a central source. The second was the suggestion to give more money than originally asked for, so that the program would be competitive in terms of production values with the entertainment shows for children seen on the dominant commercial networks; in that way it was hoped that the new show would be able to attract and hold an audience.

Although government funders were the ones who required outside advisors, e.g., consultants from the impacting worlds of academia and media, there are relatively few examples of substantive input from "outside" during any phase of the project. Even less can be said regarding input from either the adopters or the users. Public television station managers,

collectively taken to represent a major element within the adopting agency, were not contacted until the year before the program's premiere. Even then contact was initiated to insure a desired place on the morning schedule rather than to solicit production help. Local educational administrators were reached simultaneously with local station managers; very often the administrators were asked to relinquish time they had contracted for to be used for in-school instruction. The users were never formally consulted. The ultimate users, preschoolers, and secondarily their parents and siblings, were a diverse group. Research on children's viewing habits was conducted by the CTW research staff. As production progressed, program segments and finally entire shows were viewed by groups of young children watching in different settings, e.g., home or day care centers. Of necessity, research and pre-testing were conducted on small groups. This procedure is considered an important allowance for user input by CTW.

Thus, a programming innovation to be disseminated on a national basis was developed within a closely-drawn circle of contributing professionals. Therein lies another lesson to be learned, one that pertains to the crucial entrepreneurial element. There is no reason to believe that given the proper circumstances any self-appointed innovator will succeed. A quality that distinguished these innovators from others was their ability to keep control over their project, to keep a close reign on it, and this circumstance was complemented by their ability remain open to the advice of others without losing direction in the process. In other words, the entrepreneurs learned to distinguish between capsules of advice and to separate the good and the workable from the bad and the inappropriate. Literature on the "Sesame Street" experience is replete with recollections of individuals hesitant to participate for

fear that the merits of the project would be advised into meaninglessness. The series of five seminars conducted during the summer of 1968 reveal that, from whatever motivation, outside advice was sought without the planners succumbing to the resulting inundation. Yet when relevant advice was offered, such as the OE suggestion to upgrade production values from those originally proposed, the innovators responded to the merits of the suggestion. Another manifestation of this quality recurs in Polsky's analysis; the originators honed down the objectives of the project to manageable proportions in an attempt to demonstrably succeed in even a few areas deemed important when assessing the worth of the undertaking. Labeled "conservative" by Polsky, one might ask if this was not merely exercising common sense or responsible management techniques. The planners were then able to say to funders and public alike that it was well worth taking a chance on them.

At this point, the relevant lessons of "Sesame Street" for this audience become abstract. A receptive climate, the ability to make or respond to critical decisions, and the caliber of the entrepreneurial factor all interface to determine the ultimate success of an innovation. Although all of these things were going for "Sesame Street," there were other factors which could well have mitigated against it. The limitations of the adopting agency and the lack of consultation with adopters and users could all have spelled disaster. Was this a lucky innovation? That is, of course, one possible interpretation. Placing it in another context, one might write of the intangible human factor ... the hunch ... or the willingness of those in a position to help to "take a chance" on individuals who approach them with a good idea. All other things being equal, a decision to back particular entrepreneurs will partially be based upon a favorable assessment of the innovators ability to get the

job done. And decisions of this nature cannot be tamed into a commonplace procedure.

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Chapter 3: COMPUTER-ASSISTED INSTRUCTION IN ELEMENTARY EDUCATION: IMSSS-CAI

by Lane Gustafson

I. INTRODUCTION AND OVERVIEW

This is the second case study of a specific innovation in the education sector. It examines the development of computer-assisted instruction (CAI) for use in elementary education by the Institute for Mathematical Studies in the Social Sciences (IMSSS) at Stanford University.

Following this introduction, Section II details the history of the initiating unit and the innovation itself. The Institute for Mathematical Studies in the Social Sciences, through the initiatives of Patrick Suppes and Richard Atkinson, made a decision in the fall of 1962 to develop and operate a complex learning laboratory utilizing computer-based instruction. It was from this laboratory, the Stanford-Brentwood Computer-Assisted Instruction Laboratory, that their considerable contributions to the development of computer-assisted instruction originated.

Section III outlines the subsector, or environment, towards which computer-assisted instruction was directed and in which it sought to emerge, namely the American educational scene. It is worth noting that there were significant factors operating in education in the United States at the time which were favorable to the introduction of computer-assisted instruction. Chief among these factors were criticisms of the effectiveness of education to provide scholastic excellence and in the eyes of some observers, to provide adequate skill development. The failure of the educational system to teach children from "disadvantaged" or minority backgrounds is particularly noted.

Computer-assisted instruction is defined and explained in Section IV. The Institute for Mathematical Studies in the Social

Sciences developed computer-assisted instructional programs designed to offer supplementary drill-and-practice in mathematics and language arts. The programmatic models used in this drill-and-practice are discussed. Most of the effort in this investigation is focussed on mathematics rather than the language arts. Materials on the mathematics activity appear to be more readily available.

Section V discusses factors that played important roles in determining the extent of acceptance and utilization of Stanford's computer-assisted instruction program. In skeletal form, they include: (1) attitudes about CAI and traditional instruction, and (2) funding. Particular emphasis is placed on the attitudes of both initiators and adopters toward computer-assisted instruction and towards traditional instruction.

The participation and attitudes of the adopters (school systems) are examined in Section VI. After defining the adopters, this section explores the particular situation encountered by the Eastern Kentucky Educational Development Center (EKEDC) in its adoption of CAI in 1967. Economic and political factors in Eastern Kentucky are given the largest consideration.

Section VII parallels Section VI, except that it defines and explores the users of computer-assisted instruction: elementary school students. In order to adequately deal with the users, consideration is given to compensatory education and its role in contemporary education. From this background, the section discusses the particular usefulness of CAI for disadvantaged children. Another focus in Section VII is on the reactions of users to computer-assisted instruction, particularly the Eastern Kentucky children.

Section VIII evaluates the innovation and makes recommendations for further studies aimed at maximizing computer-assisted instruction's potential in education. The impact of the innovation is evaluated in terms of the educational system in general and in terms of students in particular. In addition, consideration is given to the extent of utilization and acceptance of CAI.

Section IX, the concluding chapter, summarizes the findings of this study in order to provide a concise foundation for developing policy formats useful in the evaluation of other innovations. This investigation was heavily dependent on the prolific studies written through the Institute for Mathematical Studies in the Social Sciences at Stanford University and upon a personal interview in November, 1974 with Dr. Patrick Suppes, director of the Institute. Information available from other sources is generally fragmentary and incomplete.

II. THE HISTORY OF THE INITIATING UNIT AND THE INNOVATION

Introduction

Education in the United States has developed in several stages. Alvin Toffler, in his book Future Shock, has described current educational conditions in the following way:

> Today children who enter school quickly find themselves part of a standard and basically unvarying organizational structure: a teacher-led class. One adult and a certain number of subordinate young people, usually seated in fixed rows facing front, is the standardized basic unit of the industrial-era school. As they move, grade by grade, to the higher levels, they remain in this same fixed organizational frame.[1]

A recent innovation in elementary education, which began in the early 1960's, offers an opportunity, in the eyes of some people, to create an educational renaissance by using computers to individualize instruction for students.[2] As reported in Jamison, Suppes and Wells, "... this technology provides the richest and most highly individualized interaction between student and curriculum of any of the methods of instruction yet developed."[3]

The Institute for Mathematical Studies in the Social Sciences

The Institute for Mathematical Studies in the Social Sciences, a research and development laboratory at Stanford University which specializes in investigations of learning theory, has been a major

contributor to the development and use of computer-assisted instruction in education. Patrick Suppes, currently director of the Institute, is in large measure responsible for guiding the Institute's development of CAI and establishing CAI as a factor in American education.

Dr. Suppes, whose Ph.D. is in philosophy, came to Stanford University in 1950 to do research at the Applied Mathematics and Statistics Laboratory, a research institute that began at Stanford in the 1940's. Curriculum research on elementary education began within that framework in 1956. The Institute, as it now exists, began in 1959 as a spin-off from the Laboratory, with a broad orientation towards research on mathematical psychology, mathematical economics, and quantitatively oriented work in education.[4]

Educational research at the Institute was initially funded by the Carnegie Corporation of New York and later by the National Science Foundation and U.S. Office of Education. Although the Carnegie Corporation contributed one million dollars towards the Institute's research, 95% of the subsequent funding (approximately fifteen million dollars) has been obtained from the Federal government, presumably over a period beginning approximately in 1964 and continuing through the early 1970's.*

Computer-Assisted Instruction

According to Suppes, the real thrust towards investigation of computer-assisted instruction came in the fall of 1962, when Dr. Suppes and Dr. Richard Atkinson, a psychologist with particular interest in reading development, proposed a laboratory for the study of complex

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*This and subsequent information about the development of IMSSS-CAI is taken from statements by Patrick Suppes in a personal interview, November, 1974.

learning.* In an effort to achieve complete control of the presentation material, Suppes and Atkinson proposed a computer-based laboratory. In their estimation, computers offered an opportunity for interaction that could not be achieved via any other medium, particularly in skill areas, such as reading and mathematical functions, which are the primary areas of emphasis in elementary education.

Commercial electronic digital computers had been introduced in the United States in 1951, and therefore, by the time the Institute began its involvement in this project, computers were in their second generation of commercial usage. A significant factor in the Institute's development of CAI was that at the same time they began developing the complex learning laboratory, computer time-sharing had been perfected. For a more detailed description of the development of computers, including a definition of time-sharing, see Section IV.

One of the co-developers of time-sharing, Dr. John McCarthy, was also doing research at Stanford University, and the Institute was able to share the first computer they used, a PDP-1, with him. At that time very few time-sharing systems existed in the world and the PDP-1 represented one of the most advanced in this country. This access to the best computer technology available was a definite asset to the research undertaken by Suppes and Atkinson. As Dr. Suppes himself puts it, "... we were right on the edges of the computer

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*In lay terms, this laboratory was intended to study materials of more complexity than those previously examined in traditional psychological investigations of learning.

technology, and by and large that's been true; we've pushed throughout our work to the edges always of computer technology resources."

CAI Goes to School

By December, 1963, the laboratory for complex learning investigations at the Institute had begun operations, and through June of 1964 demonstrations of CAI were held at Stanford involving a total of approximately thirty-seven children in kindergarten, fifth and sixth grades. The staff at the Institute used the summer of 1964 to continue development of CAI programs, particularly for the first grade and fourth grade in mathematics and mathematical logic. Also in the summer of 1964, the Office of Education granted a contract to the Institute to establish a computer-based laboratory in a public elementary school to investigate CAI over an extended period of time. The school chosen for this laboratory was the Brentwood Elementary School in East Palo Alto, California. While the Institute utilized data from the computer-assisted instruction programs for investigations of complex learning, CAI in itself became an area of investigation and research.

By the following September, preliminary CAI programs were ready for testing and by the end of the school year they had been revised and retested on eighty-seven children, twenty-eight of whom were extremely bright. It was during this period that the first remote control (teletype) operations began. In the school year 1965-66, three local schools tested the Stanford CAI drill and practice programs with approximately 225 students.

It was in September of 1966 that the Stanford-Brentwood Computer-Assisted Instruction Laboratory, housed in a special facility at the Brentwood Elementary School and supported by the previously mentioned 1964 Office of Education grant, opened, serving one hundred children.[5] In their report on this phase of the project, Computer-Assisted Instruction: Stanford's 1965-66 Arithmetic Program, Suppes et al state that "the important difference between this project and previous work at Stanford and elsewhere is that the terminals were taken to an ordinary elementary school, with the goal of having computer-based terminals operational on a daily basis throughout the school year."[6]

The school years 1966-67 and 1967-68 were marked by considerable expansion of activity by the Institute. More than 1500 elementary school students in California were having regular interactions with computer-assisted instruction by June of 1967, and in September of the same year, projects were running in California, Mississippi (primarily McComb), Iowa, and Kentucky, connected to the central computer at the Institute by telephone lines (longlines), and serving 4,736 students. In 1968-69, the number of students increased to 6,352, but there was a marked decrease the following year, 1969-70, to 3,217 students. Table I summarizes the number and, in some cases, location of these students.

Computer Curriculum Corporation

In 1967, a private company known as Computer Curriculum Corporation was formed as a spin-off from the Institute of Mathematical Studies in the Social Sciences with Patrick Suppes as its president.

Table I

Numbers of Students Utilizing Stanford Programs in Computer-Assisted Instruction[7]

Program	School Years 66-67	67-68	68-69	69-70
Drill-and-practice mathematics grades 1-8 (block structure)				
California	1,500	1,441	2,475	122
Iowa	-	640	-	-
Kentucky	-	1,632	1,060	-
Mississippi	-	640	2,113	-
Ohio	-	-	101	-
Washington	-	-	92	139
college level				
Tennessee (algebra)	-	-	206	183
Tutorial primary-grade mathematics	53	73	-	-
Tutorial reading, grade 1	50	88	-	-
Drill-and-practice in initial reading grades 1-3, remedial 4-6				
California	-	-	442	642
Language arts	-	-	-	30
Drill-and-practice mathematics grades 1-6 (strands structure)				
California	-	-	-	1,713
Ohio	-	-		165
Washington, D.C.	-	-	-	39
Tutorial computer programming	-	-	115	177
Tutorial logic and algebra, grades 4-8	76	195	49	459
Tutorial problem-solving, grades 5,6	-	27	20	18
First and second-year Russian	10	30	52	77

CCC produces software (educational programs) and leases them, along with some hardware (small, self-contained computer systems), to individual school systems on a decentralized basis. Whereas the Institute is research oriented, CCC is basically entrepreneurial in nature, organized to deliver operating services. In Dr. Suppes' view, entrepreneurial development "is a sort of final level of technological innovation."[8]

During the initial years of existence of CCC, and especially during the 1970-71 school year, a trend developed in funding of computer-related educational activities. Whereas the original drive in government funding, through the U.S. Office of Education and the National Science Foundation had been towards developmental endeavors like the Institute's, the U.S. Office of Education funding began to dry up and, on a nationwide level, CAI research fell off accordingly. (See Table II.)

Table II

Number of Computer Projects Funded by the U.S. Office of Education (by years)[9]

1966	1967	1968	1969	1970	1971
72	80	137	60	17	3

Although the Institute itself continues its research in CAI,* it no longer

*During the early 1970's, the Institute was active in the field of CAI utilization for deaf students. Although the Institute's funding for CAI research and development for elementary education has fallen off, two CAI systems currently receiving support from the National Science Foundation are PLATO-IV at the University of Illinois (Urbana), and TICCIT, developed by the MITRE Corporation. These systems are to varying degrees larger than the CCC system and seek to achieve economies of scale in education. Current experiments are focussed on the community college level.

operates projects in the public schools to the extent it did during the years 1966-1970.

Although research grants have fallen off, funding of commercial CAI usage, through discretionary funding in individual school systems via the Elementary and Secondary Education Act, began to pick up. According to Dr. Suppes, Computer Curriculum Corporation leases a substantial amount of the commercial CAI software and hardware in operation. In Dr. Suppes' words, "most of the curriculum running in schools as regular computer-assisted instruction is Computer Curriculum Corporation's product."[10] Since these programs run on a decentralized basis, and are not part of a larger, research-oriented project, specific information is difficult to find. Dr. Suppes estimates, in what he considers to be an understated figure, the number of students using CAI materials from CCC to be 25,000, located in 25-30 states.

III. THE SUBSECTOR (ENVIRONMENT): THE AMERICAN EDUCATIONAL SCENE

Older Educational Traditions

Education in the United States has undergone several transitions. Originally, American education followed traditional European guidelines. It was the concern of the socially and economically elite members of society, with emphasis on the classical languages and erudite subjects. Most education was geared toward producing clergyman, lawyers, and statesmen; individuals with strong community leadership roles. By and large, ordinary citizens received only a cursory education in reading, and arithmetic, if any.

As the Industrial Revolution blossomed in the United States, educational leaders such as Horace Mann began to see the need for free, universal education, and the public school system developed to meet this need. At about the same time, massive immigration of Europeans to America began, and a new, far-reaching philosophy of education took root.

The concern of social reformers at the turn of the Twentieth Century with the Americanization of immigrants and the corresponding concern of manufacturers and businessmen with continued economic productivity and growth came together in John Dewey's theories of progressive education. School began to be regarded as a tool for facilitating life adjustments and providing socialization. Progressive education differed from the earlier, classical education in that it

was present oriented, not past oriented. This philosophy has been the dominant educational theory in the United States during the Twentieth Century.[11]

Contemporary Criticisms

In recent decades, however, American education has received more and more criticism from educators, legislators, parents, and students. Much of that criticism arose because many people felt that the public school system had failed to maintain intellectual excellence among students. One example of this was an apparent failure of the school system to teach reading and other basic skills successfully, particularly to minority and/or poor children.

According to Charles Silberman, in Crisis in Black and White, a book contemporary to the period during which CAI began to emerge, this dissatisfaction corresponded with, but was not caused by, the Soviet space achievement in 1957 when Sputnik was launched. The technological advance that Sputnik represented "added force to criticisms and changes that had been underway for some years before."[12] Americans became increasingly more interested in promoting mathematical and language arts skills in schools in order to insure scholastic and scientific competition with the Soviet Union.

Another corresponding social condition was the increasing drive to upgrade the position of minority members of American society, marked by a vocal and growing civil rights movement among blacks and liberal whites. The Civil Rights movement had gained impetus during the years of Lyndon Johnson's Great Society programs, which made an effort to extend the benefits of American prosperity to all citizens. In the

field of education, one of the largest legislative efforts was the Elementary and Secondary Education Act of 1965 (ESEA).

Elementary and Secondary Education Act of 1965

The ESEA outlined in its seven categories, called titles, a broad range of educational needs which would be met by federal funding. The section most germane to the present discussion is Title I, which offers "financial assistance to local educational agencies for the education of children of low-income families and extension of Public Law 874, 81st Congress."[13] In more specific terms, the Division of Compensatory Education in Washington, D.C. defines an eligible child under Title I as:

> one who needs special educational assistance to perform at the grade level for his age. The term also includes children with special educational needs resulting from poverty, neglect, delinquency, handicaps, or cultural, economic, or linquistic isolation from the general community.[14]

The other six ESEA Titles, which occasionally provide sources of money useful in CAI applications in schools, are as follows:

II. School library resources, textbooks, and other instructional materials.

III. Supplementary educational centers.

IV. Educational research and training.

V. Grants to strengthen state departments of education.

VI. Education of handicapped children.

VII. General provisions.

Charles L. Schultze, in his book The Politics and Economics of Public Spending, has a interesting and pertinent analysis of the ESEA. According to him, the ESEA, which opened up large, new areas of federal aid for education, won support in Congress because it was essentially

non-specific enough to have garnered support from three divergent groups: (1) those desiring more federal aid to education; (2) parochial school interests; and (3) those interested in combatting poverty.[15]

Another facet of the ESEA is that it provides multiple centers of control for educational decision-making. The state and local educational agencies retained control of the Title I funds, which were allotted on a formula basis depending on the number of low-income students in a school, while Title III funds were direct federal project grants allocated for particular innovative educational programs, and under federal control. It should be noted that in 1967, Congress passed the Green Amendment, which substantially limited federal control of Title III funds and shifted that control to state boards of education.

General Organizational Structures

The organization of school systems is complex, and varies from state to state. However, there are some basic similarities in each system. First of all, responsibility for running school systems rests on the state governments. Therefore, laws concerning days of yearly attendance, instructional material, and minimum qualifications for school personnel, among other requirements, are dictated by the state.

Above and beyond basic state requirements, however, local boards of education usually have final say in local school affairs. For example, from the list of state approved textbooks, local officials may select any books they desire. After meeting minimum requirements, local boards may impose their own additional qualifications for employment. And while they must provide at least the basic course

requirements of the state, they may add their own requirements for promotion or graduation. In addition, although some monies for education are provided by the state, much of school revenue is the responsibility of the local community.

Although the state governments have responsibility for governing the schools, they must also meet federal requirements in areas involving the protection of constitutional rights such as equality in education for minority or ethnic group members. The federal government exerts additional influence in that much of its financial support (like ESEA grants) are dependent on schools meeting federal stipulations. It is apparent, therefore, that local autonomy is curtailed to some extent by law and financial necessity.

In most areas of education, but especially as related to funding, procedures and tasks are formally and rigidly specified. For example, complex and detailed records must be kept of daily attendance, and Title I funds are distributed based upon the number of students who actually were present at school on a given day, and excluding any absentee students. Local schools must conform to the requirements of local boards of education and state departments of education, which in turn must conform to specifications of federal legislation in some areas.

Discretionary Funds vs. Research Grants

A distinction must be drawn here between direct grants to research institutions such as those administered by the United States Office of Education; the National Institute of Education; and the National Science Foundation; and the decentralized, user grant administered

under ESEA. ESEA funds are granted to individual school systems for discretionary use in particular schools or for particular populations of children who meet eligibility requirements.

To individual schools, this distinction is crucial. When a school participates in a research project, the expenses are generally met by the organization doing the research and entails little or no financial expenditures on the school's part. Discretionary funds like ESEA, however, belong to the school and may be spent by its administrators in the way deemed most beneficial to its students, and therefore involves decisions about which educational needs take priority. As Dr. Suppes puts it, "It's a completely different world to take something out and say, 'We want to bring it in and try it at no cost to you,' and to say, 'Okay, do you want to spend your discretionary dollars?' That's the important transition period."[16]

United States Office of Education and CAI

The U.S. Office of Education has demonstrated a marked interest in CAI over the years, beginning around 1966. However, they have not supported a central plan or policy of development of CAI uses, but rather have supported particular projects because of their relationship to particular educational problems.[17] For example, there is some feeling that the CAI project in McComb, Mississippi, a joint venture with the Institute at Stanford, was of particular interest because it offered an opportunity, during a period of national outcry about racial discrimination, especially in the South, to provide an educational innovation available to both black and white children without discrimination.[18]

There is evidence, as seen in Table II, that since 1968 there has been a reduction of U.S. Office of Education support for computer-assisted instruction. Molnar and Sherman assert in their article, "U.S. Office of Education Support of Computer Activities," that there is a trend away from development of small, component-oriented projects towards larger, systems-oriented projects."[19] In light of this, the reduction of the number of projects supported may not be so significant, especially when large projects like PLATO IV are considered; however, it is difficult to make satisfactory conclusions without information regarding the amount of federal aid to CAI projects. To this author's knowledge, a comprehensive study of this kind has not been published.

IV. THE INNOVATION: COMPUTER-ASSISTED INSTRUCTION

Computers in Education[20]

In August, 1944, Professor Howard Aiken of Harvard University perfected the first machine which can loosely be defined as a computer, the Mark I. By 1950, there were twelve computers operating in the United States. In 1960, there were approximately 6,000 computers, and by 1970, approximately 80,000 computers were operating in the United States.

Over the last thirty years, computers have undergone many transformations, which have produced succeedingly more sophisticated and less expensive models. The first generation of computers was characterized by slow operation, high electrical consumption, and heavy air-conditioning requirements. The technology upon which operation was based was the vacuum tube. In the second generation of computers, the vacuum tube was replaced by transistors, an improvement largely responsible for their tremendous growth in utilization. These computers were more reliable, smaller in size, and required reduced electrical consumption and air-conditioning compared with their predecessors.

The third generation computers utilize integrated circuits instead of transistors. These computers are much smaller, faster, more reliable, and cheaper than the second generation. For example,

in 1955 it cost about ten dollars to perform one million additions on a computer; by 1970 that cost had been reduced to less than one cent.

Originally, computer operators utilized off-line batch processing (still the most prevalent mode of computer use), in which the program was presented to the computer system on tapes or punched cards which are "batched," or combined, with the programs of other users. Ordinarily, batch-processing could take up to several hours for completion. A recent, much more efficient method of utilizing computer resources is time-sharing, in which the computer performs partial operations for several users almost simultaneously by doing those operations cyclically, a process called interleaving. The computer is able to do this because it has a response-time of 5 milliseconds (1/200 of a second), while humans are able, at best, to depress a key on the teletype terminal only once every 50 milliseconds (1/20 of a second). The additional time that the computer has between key depressions is used to respond to other users. The extreme speed of the computer gives "each user the illusion that the computer is devoted to him exclusively."

The development of time-sharing was a key factor in the applicability of computer systems to instructional purposes. CAI relies on immediate feedback to the student in its teaching role, and the slowness and expensiveness of off-line batch processing would render it virtually unusable in learning situations. As Levien puts it:

> The problem of permitting multiple users to be on-line with a computer in an efficient manner has been solved rather well through the use of special hardware terminals in a time-sharing environment.[21]

Definition of CAI

Computer-assisted instruction is a man-machine relationship utilizing two-way communication to foster human learning and retention. In this relationship, the human is a student, and the machine is a computer-system. The role of the computer-system is not to act as a tool for problem-solving or information retrieval, but rather to instruct the student. During the instruction, students are the only humans interacting with the computer system.[22]

Tutorial CAI

During the twelve year period since the Institute for Mathematical Studies in the Social Sciences began its research on computer-assisted instruction, it has utilized three major types of CAI. The first, and a relatively small portion in the long run, was tutorial instruction. In this mode of instruction, the computer teaches all, or most, of the subject in question. To do this, it provides lessons consisting of simple and direct explanations of new concepts, followed up by practice problems.

It was tutorial CAI that the Institute utilized when it opened the Stanford-Brentwood Computer-Assisted Instruction Laboratory in 1966. The Institute was totally responsible for the mathematics instruction of the children in the tutorial program, and it should be noted here that they did not rely on the computer system (an IBM 1500) to provide all of the instruction. In addition, they retained a mathematics teacher from the Institute who provided additional mathematics lessons in a small group format to children participating in the Stanford-Brentwood Laboratory program.[23]

Besides teaching mathematics, the computer system acted as a data gathering device. The computer was able to collect records on more than seventy items, including the identification number of the student making the response, the identification numbers of the problem, lesson, and program, and the classification of the student response, to name a few. Learning to accurately measure student learning and achievement in order to draw conclusions about the way children learn has been a prime objective of the Institute's research. The data collecting abilities of the computer are very important in this light. According to Suppes and Morningstar:

> Data of superb detail and quality can be collected. These data can be analyzed in a fashion as theoretically and experimentally rigorous as is customary in highly controlled experiments in psychology. Not only can detailed conclusions about individual parts of the curriculum flowing from detailed descriptive data be made, but also models of learning that deal with the subject matter itself can be attempted. In our judgement this should ultimately prove one of the most important benefits of computer-assisted instruction.[24]

Perhaps the most serious drawback of tutorial CAI is its cost. As Dr. Suppes remarked, "We have had a fair experience with tutorial efforts in elementary schools, and I think you can do quite a bit with it, but frankly, it's too expensive."[25]

Singh and Morgan, in 1971 cited costs of computer-assisted instruction based upon 1970 literature as being in the range of $2.60 to $15.00 per student contact hour.[26] Traditional elementary instruction (teacher administered), was estimated in the same study to cost about $0.60 per student contact hour. CAI was significantly more expensive in this comparison, and tutorial CAI could be expected to be more expensive than drill and practice CAI.

Block Drill-and-Practice CAI

The second type of CAI that the Institute developed was drill-and-practice. Rather than teaching the concepts as tutorial CAI does, this type of CAI leaves the responsibility for the presentation of new materials and concepts on the classroom teacher. The computer system provides supplementary practice in using the new skills by providing drills of appropriate materials, hence the name, drill-and-practice. Dr. Suppes has stated; "probably the primary problem in the schools is to provide for systematic, regular, well-defined maintenance of those skills [mathematics, reading, language].....The problem of forgetting is more severe than the problem of learning."[27]

The following example will illustrate the computer's value in drill-and-practice. An ordinary mathematics textbook for lower elementary grades contains from 2,500 to 4,000 exercises. Because of the time-consuming nature of the ordinary pencil-and-paper method of problem solving, and the demands of helping many children, no teacher normally covers all the exercises in a textbook. However, using a computer terminal five to fifteen minutes per day for an average of one hundred-fifty days out of a one hundred-eighty day school year, according to Suppes and Morningstar, a student can cover approximately 3,000 drill-and-practice exercises, thus equalling or surpassing the average amount of mathematics practice available to students in traditionally administered instruction.[28]

Stanford's drill-and-practice program was organized into units of concepts called blocks, arranged sequentially to correspond approximately to the order of concepts in the textbook Sets and Numbers, written by Dr. Suppes.[29] Each block had five levels of competency,

with level three being average, level one remedial, and level five accelerated. All students began new blocks at level three and were moved up to more difficult work, down to less difficult work, or kept on a plateau by the computer, depending on their mastery of the problems as reflected in the percentage of correct responses.

Mastery of level five problems was necessary for advancement to the next block, and each block took from three to twelve days to complete if one lesson was taken each day at the computer. Teachers were basically free to select whichever block was most appropriate to their daily lesson. Approximately three to five days were allotted to presentation of new material before drill-and-practice on the new concept began.

Strands Drill-and-Practice CAI

Later, the original block method of presentation shifted to the strand technique. There were several differences between the two, although the basic theory of drill-and-practice presentation continued. The strand program is based on an analysis of three major mathematics series and is not tied to Sets and Numbers, as the block program was. According to Dr. Suppes, all of the fifteen major elementary mathematics series share enormous agreement on the basic development of mathematical topics, and strands mathematics is aimed at the core material that most schools will be teaching. CAI strand programs have been used with at least ten different mathematics series.

A second major difference is that the strands presentation is not tied to the concepts being taught in the classroom. Each individual mathematics function (addition, subtraction, multiplication, and

division) is separated and stored on an individual strand in the computer's memory. These strands are continuous from the first grade level to the seventh grade level. Each student can theoretically continue to progress as long as he/she is able to adequately perform the required work. In a grade three class, for example, grade placement on a particular mathematics strand may range from 1.5 to 4.9, according to Dr. Suppes. An additional benefit of the strands continual placement format is that it has proven to be a fairly accurate predictor of student test scores and grade placement.

Another feature of the strands program is that, unlike older computer-assisted instruction programs, it does not store a finite number of already prepared problems for the student. In systems where that was true, a student who encountered difficulty with a concept would inevitably be presented with repetitions of past work, and groups of students working on the same concept would have nearly identical interactions with the computer, increasing the probability of copying or of memorizing rather than learning.

With strands, the problems are generated from the computer itself, requiring much more sophisticated initial programming, although in the long run providing a more efficient program. Singh and Morgan have explained the same operation in the following way: "Today the computer is usually programmed to calculate unique responses to varying student inquiries by making use of the algorithms stored in its memory."[30]

This method virtually eliminates the possibility of students sharing answers or of an individual student reencountering the same

problem twice. In fact, Dr. Suppes asserts that a student never repeats a problem, but rather sees different problems at the same level and function.

Computers in the Schools

Originally, many of the remote control (teletype) terminals were in the individual classrooms and were tied by longline (telephone) to a central computer. This presented several problems. Longline hookups proved to be very expensive, and often constituted a major share of the cost of a CAI program. They were also susceptible to considerable maintenance problems, often closing down the computer system for periods of time. A more recent approach, particularly utilized by Computer Curriculum Corporation, is to use small, self-contained computer systems which do not rely on extensive longline facilities. Another benefit of these small systems, according to Dr. Suppes, is that the technology of small computer systems has improved enormously and is much cheaper than it was five years ago.

A third problem with classroom-contained terminals was that they proved disruptive of ordinary activities due to terminal noise (typewriters) and the constant movement of children around the classroom, and they required specially constructed enclosures (often renovated closets). In addition, teachers were often unable to handle even minor terminal breakdowns, despite their preliminary training sessions regarding CAI. The normal procedure now is to collect all the terminals in a school into one place, accommodating several children at a time, and under the management of a paraprofessional proctor trained to manage the children, assist them with difficulties, and

handle minor terminal problems. Extensive terminal maintenance is generally handled under standard maintenance contracts.

Technical Personnel

Computer-assisted instruction, as it appears to the student, is the end product of painstaking technical work. In their account of the 1965-66 arithmetic program, for example, Suppes et al outline six major areas of supporting personnel. These are: curriculum writers and editors; computer programmers; coders; program supervisors in the school; electronic technicians; and research psychologists.[31]

The curriculum writers and editors were occupied with the construction of the actual problems and drills, particularly with the development of parallel sets of drills at the same level. Especially in the early years, when appropriate computer languages and software had not been developed, the computer programmers were required to expend substantial energy on producing sophisticated programming. The coders assisted this effort by actually inputing the drills into the overall system.

Program supervisors, strictly speaking, were not in-house personnel, but worked in the schools, overseeing all aspects of the operation and providing training and evaluation sessions for the school staff. The electronics technicians worked with technical maintenance both at the school and at the computer laboratory on the Stanford campus. In addition, research psychologists were used to interpret and develop the data resulting from operations in the school.

Figure I, which follows, is this author's interpretation, in flow-chart form, of the interactions described in Suppes et al.[32]

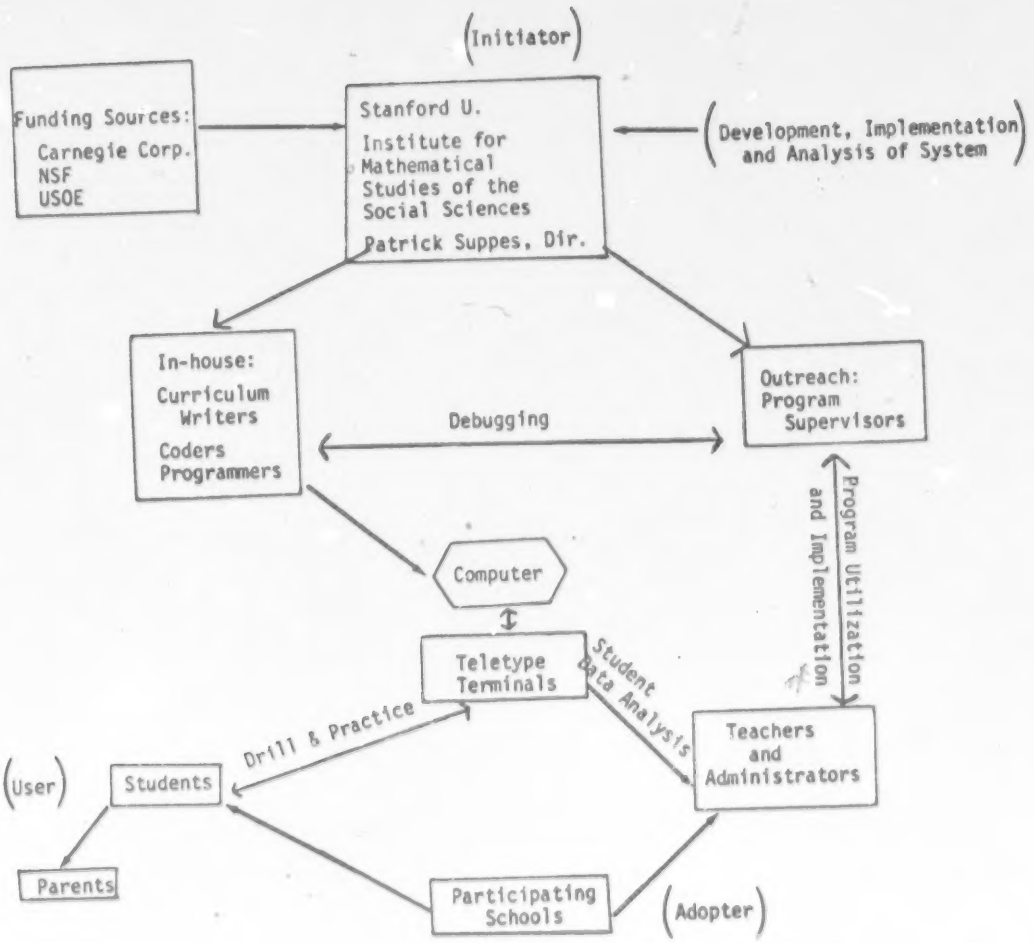

Figure I

Organizational Flow Chart
Stanford CAI Project

Each of the technical staff is identified in relationship to each other and to the adopters and users, with the computer itself the center of the configuration.

V. TECHNIQUES OF CHANGE: FACTORS AFFECTING THE ADOPTION AND USE OF THE INNOVATION

Introduction

The development and utilization of any new theory or technology is dependent on the positive interface of many related factors. In the innovation under discussion, computer-assisted instruction as developed at Stanford University, at least two major factors can be identified that had major influences on its adoption and use, although definitive boundaries between these factors are frequently blurred and overlapping. In brief they are:

1. Attitudes about CAI and traditional instruction
2. Funding

This chapter will attempt to delineate and interpret each of these factors.

Attitudes About CAI and Traditional Instruction

As one can expect, computer-assisted instruction at Stanford University was developed by individuals with positive attitudes about CAI as a tool in education. In the introduction to their book, Computer-Assisted Instruction at Stanford University, 1966-68: Data, Models, and Evaluation of the Arithmetic Programs, Suppes and Morningstar state:

> Just as books freed students from the tyranny of overly simple methods of oral recitation, so computers can free students from the drudgery of doing exactly similar tasks unadjusted and untailored to their individual needs. As is the case of other parts of our society, our new and wondrous technology is there for beneficial use. It is our problem to learn how to use it well.[33]

This pro-CAI bias on the part of the initiating unit, the Institute for Mathematical Studies in the Social Sciences, was based, in part, on implied and direct criticism of traditional instructional methods. In a separate article, Suppes and Morningstar conclude that drill-and-practice to achieve the same end result could be administered by teachers instead of by computers, but that computers add a dimension of quality control.

> What seems evident already is that the use of terminals to bring a drill-and-practice program to schools can bring a kind of quality control difficult to achieve in large numbers of schools with large numbers of teachers.[34]

Jamison, Suppes, and Wells supported this view in their report, "The Effectiveness of Alternative Instructional Media: A Survey." As quoted in Section II, they found CAI to offer the greatest potential benefit to students of any method of instruction existing. This assessment of CAI is not without caveats, however. In evaluating the statistics on student performance in several CAI programs, Jamison, Suppes and Wells also concluded that "no statistical difference" between students using CAI and those using traditional instruction were the dominant findings in research literature on CAI.[35]

In addition to conflicting opinions about the efficacy of CAI as an instrument of learning, Anastasio and J. Morgan have identified six factors which inhibit adoption and use of CAI. Briefly stated, they are:

(1) An inadequate system for software production and distribution

(2) Lack of demonstrations of CAI and efforts to convince people that CAI is cost/effective

(3) An absence of adequate theories of instruction on which to base CAI systems.

(4) The need to change the traditional roles of teachers so as to take advantage of CAI

(5) High costs of CAI

(6) A need for technological research and development[36]

Of these six factors, perhaps the need to change traditional teacher roles is the most controversial. There is an undercurrent in CAI which is succinctly stated by Patrick Suppes in "Technology in Education."

> Perhaps the most important economic problem, however, is to be toughminded about how technology can actually substitute for labor-intensive efforts by teachers... The economics of education will demand that technology be used as a substitute rather than a supplement to teachers.[37]

In the same vein, Suppes and Morningstar state:

> We would claim that the wise use of technology and science, particularly in education, presents a major opportunity and challenge [to intellectually wean children from the necessity for a teacher].[38]

However, more recent publications from the Institute have softened this view considerably, and with good reason. Any innovation which threatened the continuing role of classroom teachers as part of elementary education would surely be met with strong resistance. The Institute now makes a point of emphasizing its compatibility with traditional teaching and classroom operation. They are careful to promote CAI as an addition to regular instruction which, besides not jeopardizing the teacher's role, would actually allow the teacher more

time and opportunity to provide more individualized instruction to the students. To elaborate on this theme, Suppes et. al have said:

> In this area are many of the important and useful things that can be done to relieve the teacher of routine and burdensome tasks so that the teacher may devote time to giving more individualized attention to his students.[39]

Funding

The role of funding in the adoption and use of CAI has been examined to some extent in Chapter III of this report, particularly as it applies to decisions that adopters must make about the dispersal of discretionary funds for computer-assisted instruction if they are to shift from experimental participation in CAI to regular curriculum usage of CAI. It is important enough, however, to reiterate the fact that, in Dr. Suppes' estimation, the biggest obstacle to utilization of CAI in an ordinary school system is economic.

In an analysis of the reasons for termination of some of the experimental programs that the Institute sponsored, Dr. Suppes stated:

> Almost all programs that have terminated have been because of a shortage of funds; they didn't have the funds really to continue on their own. In most cases, we have had a very good record educationally and the decisions [to terminate] have been mainly financial. The schools that Computer Curriculum Corporation work with have got [their CAI programs] pretty well built into the Title I budgets and they are pretty stable. Most of them are in place, and a lot of them have been running three and four and five years.[40]

As implied in Dr. Suppes' reference to Title I budgets, the source of funding to implement computer-assisted instruction, by and large, has been federal, particularly ESEA. Julian Prince, in his

report on the McComb, Mississippi CAI project, which is no longer operating, states that

> We have independently (and exhaustively) investigated all large commercial computer configurations technically capable of delivering CAI. We can state without equivocation that we could not afford to operate any of the systems that we investigated without federal support.[41]

An interesting and noteworthy consequence of this reliance on federal funds for CAI, particularly due to the eligibility requirements of the ESEA (See Chapter III), is that the majority of children exposed to computer-assisted instruction are from poor urban and rural environments, and much less frequently from middle class suburban areas. As Dr. Suppes puts it, "The only kids that really get first class service or technology are poor kids; it's a nice thing really." These sentiments reflect the attitudes of many people who supported passage of the Elementary and Secondary Education Act of 1965 because they wished to improve the educational environment for poor students.

Political considerations also affect the financial environment surrounding CAI, and therefore constitute a factor in its adoption and use. Just as there was a feeling that concern over the discriminatory racial atmosphere of the South in recent decades had a positive effect on the funding of the CAI project in McComb, Mississippi (See Section III), it may be that such projects are sometimes developed by agency officials in efforts to demonstrate their potential to key local congressman as well as to respond to real educational needs. It is interesting to note that Carl Perkins was (and is) chairman of the United States House of Representatives Committee on Education and Labor at the time that the U.S. Office of Education decided to fund a computer-assisted instruction project in Eastern Kentucky, which is Mr. Perkin's home.

In order to fully comprehend the economic constraints to utilization of computer-assisted instruction, it would be valuable to look briefly at the cost of CAI. One difficulty in this examination is that literature on cost/effectiveness of CAI is difficult to locate. Another problem is that information and analysis do not easily allow comparison from one article to another. For these reasons, the following comments will, of necessity, be somewhat simplified. More detailed analysis is clearly indicated.

Jamison, Fletcher, Suppes, and Atkinson, in their report "Cost and Performance of Computer-Assisted Instruction for Compensatory Education (1971)," estimate the per student per year cost of running a computer-system, similar to those utilized by the Institute, at $75 and perhaps as high as $125 if overhead costs were included. These figures are based on a rural educational setting where the initial costs of the computer system is $3,260,000 and the annual cost of system operation and maintenance is $380,000. At this rate the estimated annual cost would be $1,845 per teletype terminal, or, since each terminal typically handles twenty-five students per day, $75 per student per year.[42]

As reported in the same article, Jamison, Suppes, and Butler (1970), estimate the cost of CAI utilizing small component systems, such as one in operation in San Diego, at $50 per student per year over normal teaching costs, assuming that there is no reduction in other outlays per student.[43] The quoted figure is for urban environments and would be slightly higher for rural settings.

Eastwood and Ballard, in an investigation of PLATO IV, the large-scale computer system being developed at the University of Illinois, estimate that even with optimum conditions, use of a PLATO terminal would cost $0.44 per student contact per hour. Adding the costs of the hardware (computer system), software (courseware), and communications (longlines, etc.) would significantly increase this cost. Estimating traditional instruction at $0.27 per student contact hour, as Eastwood and Ballard do, the cost of CAI is prohibitively high.[44] Even using Singh and Morgan's estimate of $0.60 per student contact hour, CAI is not competitive at this time under the best conditions.

It should be pointed out that Jamison, Fletcher, Suppes, and Atkinson compare their costs to the cost of compensatory education, which they set at $200 - $300 per student per year. In this light, CAI is competitive.[45]

VI. THE ADOPTERS: SCHOOL SYSTEMS AND THEIR REPRESENTATIVES

Introduction

In the context of this report the adopters of the computer-assisted instruction for elementary mathematics developed by the Institute for Mathematical Studies in the Social Sciences may be considered a collection of individual schools and support agencies spanning many levels of the hierarchial, though decentralized, landscape of American education. For discussion purposes, this broad range of adopters may be placed in one of two categories. The first group would include the individual elementary school with its pyramid of personnel encompassing teachers and administrators. Subsumed within this category are those elementary schools with a large "disadvantaged" clientele, such as the rural or urban poor, which makes them eligible for ESEA monies. The second category includes those educational entities which operate on broader levels than does an individual school. This framework would embrace agencies from local school boards to federal agencies such as the Office of Education, National Institute of Education, or National Science Foundation, with state departments of education nestled in between. Schools eligible for federal grants are particularly represented because, with the budget constraints in contemporary education, the ESEA monies are powerful incentives to

adopt an innovation. Without these monies, most schools, even in affluent communities, cannot afford computer technology. It should be noted, however, that in times of economic stress, innovative educational technology, because it is seen as superfluous to traditionally administered instruction, may often be the first thing to go.

Table III, which lists thirty-five schools utilizing the Institute's drill-and-practice program during the 1966-67 and 1967-68 school years, gives some indication of the variety of urban and rural settings CAI functioned in at that time. In order to examine the adopter more closely, the following section will consider in detail the utilization of CAI in one particular setting: Eastern Kentucky.

The Eastern Kentucky Experience*

An area of Eastern Kentucky, designated as Region 7, was the site of computer-assisted instructional activity during the school years 1967-68 and 1968-69, utilizing the CAI programs in mathematics developed by Stanford University's Institute for Mathematical Studies in the Social Sciences. Although Region 7, because of its unique geographical and economic makeup, cannot be viewed as a typical CAI setting, some general conclusions can be drawn from the experiences there.

Region 7 includes that part of Kentucky referred to as Appalachia. The Region is approximately 10,000 square miles in area, and can be characterized as rural, economically deprived and relatively

*Much of the material in this section and the next based upon studies by Smith and Pohland.46

Table III. List of Participating Schools in Drill-and-Practice Program[47]

1966-67 School Year

California	
Grant Elementary School	Los Altos
Ravenswood High School	East Palo Alto
Walter Hays Elementary School	Palo Alto
Oak Knoll School	Menlo Park
Clifford School	Redwood City

1967-68 School Year

California	
Grant Elementary School	Los Altos
Garden Oaks Junior High School	East Palo Alto
Peter Burnett Junior High School	San Jose
Walter Hays Elementary School	Palo Alto
Oak Knoll School	Menlo Park
Clifford School	Redwood City
Fremont Hills Elementary School	Los Altos Hills
Mississippi	
Eva Gordon Attendance Center	Magnolia
Alma Center	McComb
Kennedy Elementary School	McComb
Universal School	McComb
Westbrook Elementary School	McComb
Taggart School	McComb
Netterville School	McComb
Otken School	McComb
Hughes School	McComb
Summit Elementary School	McComb
Lillie Mae Bryand Attendance Center	Meadville
Franklin Attendance Center	Meadville
Iowa	
Job Corps Center	Clinton
Kentucky	
Breckinridge School	Morehead
Elliotville School	Elliotville
Morehead Grade School	Morehead
Paintsville Grade School	Paintsville
W. R. Castle Memorial School	Wittensville
Pikeville City School	Pikeville
Flat Gap School	Flat Gap
Louisa Elementary School	Louisa
Sandy Hook Elementary School	Sandy Hook
Upper Tygart School	Olive Hill

isolated. The terrain is hilly, and transportation systems are generally poor. From the viewpoint of Smith and Pohland, the population of the area is marked by cultural isolation and/or localism. In their words: "The general tendency is to restrict one's view of the world to a relatively small geographic area."[48]

In addition to isolation, they noted a generally stoic attitude toward life, which, with the added factor of general poverty, tended to minimize activity-orientation and set a tone of resignation and lack of concern for deadlines or future time considerations.

Educationally, Region 7 consists of thirty-five independent school districts tied together by a planning agency known as the Eastern Kentucky Educational Development Center. An example of EKEDC's consolidation of the individual school districts is the existence in its structure of a superintendents' organization for the superintendents of Region 7's many school districts. One broad function of EKEDC can be identified generally as widening the relatively restricted outlook of the area into a more regional perspective. Specifically, in terms of the CAI project, EKEDC wrote the proposal for government funding, made decisions about the dispersal of resources, and attempted to coordinate CAI activity for the region.

The Economics and Politics of CAI in Region 7

In 1967-68, as seen in Table III, ten schools participated in the CAI project, with thirty teletype terminals distributed among them. In 1968-69, the same number of terminals were spread out over the entire district, with no more than one terminal per school.

By 1969-70, the CAI project was no longer operable in Region 7. The reasons for this failure to sustain CAI operation can be traced to

economics, both in system cost and funding, and to a broad range of human considerations subsumed under the heading of politics.

The EKEDC's proposal for 1967-68 requested $417,000 in funding for the operation of its existing thirty terminals and the expansion of the project to include thirty additional terminals. However, funding for the project was cut to $258,000, insufficient to expand the program, and, in fact, causing cutbacks, particularly of support personnel at the Institute at Stanford. The additional problem that the requested funding was not certain until late fall of 1967 delayed the implementation of preliminary preparations, such as arranging for longline connections, and consequently delayed to start of the program from early September to October 7.

According to Smith and Pohland, one factor in the reduced funding and its delay in being assured was the passage in Congress of the Green Amendment to the ESEA.[49] This legislation shifted dispersal of Title III funds from the federal government to the State Departments of Education. A general leaning towards an 'equity policy' (more widespread distribution of funds) on the part of state authorities tended, in the opinion of Smith and Pohland, to "reduce available funds, generate competition for funds, and consume the scarce time and energy resources of the administrators of the CAI project."[50]

The forced cutback in expansionary plans did have positive political consequences, however. According to Smith and Pohland,

> It strengthened ties between the individual superintendents and contributed to the autonomous decision-making role of EKEDC. It helped to consolidate the political-educational power of the organization in determining the educational destiny of Eastern Kentucky.[51]

In their analysis, however, Smith and Pohland do not overlook the negative consequences of this cutback. Fewer students had access to CAI, and those that did had fewer lessons per student, resulting in a lessened impact on educational achievement. Teachers were forced, with generally negative reactions, to take over supervision of the terminals because terminal supervisors could not be hired, increasing the teachers' work load. And because of the decision to spread the terminals out over the area, the small (usually one individual) maintenance capacity was severely taxed, increasing technical difficulties and creating a service time-lag.

Adding to these difficulties, Region 7, in terms of available personnel, had a general lack of trained personnel, personnel trained in the implementation and upkeep of sophisticated equipment, and was characterized by a high rate of manpower turnover, including such essential organizations as EKEDC and the local telephone companies, due in part to the lack of opportunity in the area. One way that these staff problems were handled was to send staff members out of the region for training. Smith and Pohland have noted, however, that while this may have beneficial effects in the long run, it certainly contributed in the short run to dysfunction of the CAI project.

As noted previously, one negative effect of the financial cutback was reduction of staff at the Institute. Under these circumstances, according to Smith and Pohland,

> ...the lessened financing placed a tremendous burden upon the remaining staff in terms of research and development as well as maintaining viable service on a day to day basis.[52]

This specifically affected the Eastern Kentucky project not only by increasing technical difficulties, but also because it forced

the Institute to cancel plans to begin using the strand type of drill-and-practice in Eastern Kentucky, substituting instead the block type. Unfortunately, the area teachers had been trained during a summer workshop preceeding the 1968-69 school year to implement the strand program, which multiplied the technical difficulties, caused increased shutdowns, and multiplied teacher frustration.

In assessing the CAI project as an innovative program, Smith and Pohland point out the role of a research organization, such as the Institute, in constantly improving and upgrading the conceptual and operational parameters of the innovation. However, they see this role as detracting in some ways from the smooth operation of an educational program and disrupting the users' sense of continuity. They conclude:

> Perhaps basic to all this is the nature of a highly creative, innovative group such as were assembled in the Stanford CAI group. Our impression is that the group was primarily research and development (R & D) rather than commercial service oriented.[53]

Keeping this in mind, they point out an issue of broad concern in the consideration of innovative processes.

> The major issue, however, concerns the number and kinds of changes to be made in an innovative program while it is in process. Benefits as perceived by innovators may be perceived differently by people who have limited resources to carry out the administrative duties in communication, in training, and in reorganizing systems necessary to attain the benefits. And the "benefits" may be perceived drastically differently by the ultimate users -- the teachers and pupils who find themselves as pawns in a system which changes independently of their control and in surprizing and unanticipated ways. When the machine doesn't work as it is supposed to, a "benefit" cannot be discriminated from a "breakdown." We think a

> distinction between the R & D stance and the commercial service stance is important conceptually and practically.[54]

Another factor in the Eastern Kentucky project was the coordination of multiple organizations, agencies, and companies which were all necessarily involved in bringing CAI to the area. For example, in a project dependent on longlines (telephone lines), five independent telephone companies serviced various parts of Region 7: General Telephone, Southern Bell, Foothills, Rural Mountain, and Kentucky Telephone. (See Table IV.) Not only was coordination of service a problem here, but pinpointing the source of the difficulty and determining the responsible company was a problem. The following table of involved groups gives some idea of the complexity of the situation. Certainly coordinating their various functions and working together created interorganizational conflicts and tensions, not to mention delays in taking action, which were dysfunctional to the CAI project.

Finally, in a separate report, Pohland and Smith identify two additional, interrelated developments that mitigated against CAI in Eastern Kentucky. Realization on the part of school administrators of the potential of computers for administrative tasks along with state government consideration in Kentucky of establishing regional data processing centers shifted focus away from the instructional potential of computers to the administrative potential. Pohland and Smith conclude:

> That shift is now almost complete. Computerized administrative data processing services were scheduled to begin in early 1971, and the CAI function has been

Table IV[55]

Organizations Involved in the Region 7 CAI Project

1. Eastern Kentucky Educational Development Center
2. Morehead State University, Morehead, Kentucky
3. Stanford University, Palo Alto, California
4. Central Midwestern Regional Educational Laboratory (CEMREL), St. Ann, Missouri
5. United States Office of Education
6. Kentucky State Department of Education (including various subgroups like the Advisory Council)
7. Five telephone companies
8. Hardware suppliers (including Western Electric, DEC, and RCA)

deferred indefinitely. As is the case at the instructional level, systemic forces at the administrative level tend to direct computer use away from the CAI program.56

VII. THE USERS: ELEMENTARY SCHOOL STUDENTS

Definition of the Users

In the context of this report, the users of the innovation are defined as any children utilizing computer-assisted instruction in elementary mathematics as developed by the Institute for Mathematical Studies in the Social Sciences at Stanford University, including those children using CAI from Computer Curriculum Corporation, an allied organization. As mentioned in Section VI of this report, many of these children are from poor urban and rural populations with large percentages of minority children. Further, many of these children are categorized by the educational system as disadvantaged and in need of compensatory education.

Compensatory Education

In her article, "Educational Compensation and Evaluation: A Critique," Scarvia Anderson of the Educational Testing Service has offered a clear and well-defined picture of compensatory education. In this definition, she is careful to make distinctions between remedial and special education and compensatory education.

> Compensatory education is a preventive and global (otherwise it would be remedial) intervention into the lives of people judged to have socioeconomic handicaps (physical handicaps would require special education) assumed to be predictive of unnecessarily limited school achievement and life chances.[57]

In the eligibility requirements for participation in ESEA funds, the federal government has established one set of criteria for judging that particular children are "disadvantaged" and therefore in need of compensatory education. Because, as previously demonstrated in this report, the vast majority of CAI projects seem to be funded by ESEA monies, the children participating in those projects are, by the government's definition at least, disadvantaged. In this light, CAI can be seen as providing compensatory education.

While Anderson's definition of compensatory education is to be lauded on its careful separation of the distinguishing differences between compensatory, remedial, and special education, it remains a fact that many individuals use those terms interchangeably. For the purposes of this report, it can be assumed that references to compensatory, remedial, and special educational assistance all refer to the same phenomenon, defined by Julian C. Stanley in his book Compensatory Education for Children, Ages 2-8.

> ...many children are disadvantaged educationally in that without special help they will not acquire such [educational] skills. They are the ones for whom compensatory education is essential.[58]

CAI and the Disadvantaged Child

It is a generally recognized phenomenon that children who are not achieving at grade level expectations are particularly benefitted by exposure to computer-assisted instruction. As shown in the following paragraphs, many reports of CAI projects available to this author to date support this claim.

Jamison, Suppes, and Wells, in their survey of instructional media, after citing the results of a particular CAI application, state

that "...This is an example of the generally noticed result that CAI drill-and-practice is more effective with students who start below grade level."[59] In the same report, they reiterate this finding. "At the present item, we can only conclude that CAI can be used in some situations to improve achievement scores particularly for disadvantaged students.[60]

> When small amounts of CAI are used as a supplement to regular classroom instruction (as with the elementary school drill-and-practice programs) substantial evidence suggests that it leads to an improvement in achievement, particularly for slower students.[61]

In reviewing the Stanford-Brentwood Computer-Assisted Instruction Laboratory, which offered initial reading and mathematics for disadvantaged children, Atkinson and Wilson noted significant gains in student achievement.[62]

In his report on the McComb, Mississippi project, J.D. Prince discusses an experiment in which children from lower socioeconomic environments who attended one school were compared to students at the same grade level from middle- and upperclass environments who attended another school. All of the children received the same computer-assisted drill-and-practice instruction. He noted that while the children from the more affluent environments did not make significant achievement gains, the more disadvantaged children did -- gains which brought them up to par with the achievement levels of the comparison group.[63]

Although concurring with the findings that CAI has particular advantages for compensatory education, Suppes and Morningstar are careful to add a disclaimer.

> The results of the data reported here indicate that an individualized drill-and-practice program in elementary mathematics will produce its more impressive

> results in school environments not educationally or economically affluent...It would be a mistake, however, to conclude that it is only with deprived or slower students that computer-assisted instruction will show really effective results.[64]

Although this investigation does not examine the phenomenon except briefly, it should be mentioned that there are strong negative feelings against the concept of "disadvantaged" children. Particularly, members of minority groups feel that this term or concept contains an implicit derogation of the child's social and cultural milieu.

Children's Reactions to Computer-Assisted Instruction

Just as it is a generally noted phenomenon that CAI has special benefits when used in compensatory or remedial ways, it is a generally noted phenomenon that children using CAI by and large have extremely positive responses to it.[65] Aside from negative reactions reflecting idiosyncratic responses of particular children, most negative feelings about CAI seem to be related to projects where significant problems, such as extended technical malfunction of the system occurred.

Even in instances like that, the overwhelming response has been positive. Suppes et. al. administered detailed questionnaires to students at the Grant Elementary School, one of the initial CAI placement sites. Many technological difficulties occurred during the first year of major operation, the year that the questionnaire was administered in, and the authors had a particular interest in discovering the impact that system breakdown had on children.

> The single most impressive conclusion from the data is that the majority of students were very enthusiastic about the teletype program at Grant School. The children felt it was fun to work on the machine, and they also believed that the drills helped them in arithmetic.

> Their motivation in arithmetic and in other subjects seemed to improve, as indicated by their eagerness to use the machine and by increased interest in other subjects. Many students showed more confidence and pride in their work, as reflected in their reaction to printed data and their willingness to discuss errors and take home their printouts.[66]

In order to present a clearer picture of the user, the following section will look closely at the children (users) of computer-assisted instruction in Eastern Kentucky.

The Eastern Kentucky Children

In observing the reactions of the children in Eastern Kentucky to CAI, the generally rural, economically deprived, and relatively isolated environment, with its concommittant lack of technical sophistication, should be kept in mind. As Dr. Suppes noted, many of these children had never seen a typewriter before. Their reactions, while they may have some general application in other situations, must also be viewed as responses possibly unique to that environment.

Smith and Pohland,[67] in their study "Participant Observation of the CAI Program," identify six broad areas of interest and investigation regarding the responses of children/users. Listed briefly, they are:

(1) Enthusiasm, Attention and Concentration

(2) Emotionality and Anxiety

(3) Animism (Verbal Interaction)

(4) Social Dimensions (Group Activity)

(5) Competition

(6) Design and Supervision

The first observation about the pupils using CAI was their enthusiasm for the drills, their attention to the work at hand, and their concentration on the drills to the exclusion of outside distractions. While not universally true, Smith and Pohland did note that:

> Published accounts of the "hold" that the terminals have on children in terms of intensity of concentration, eagerness to "sign-on" etc. had to be seen to be believed -- and we did. Our first visit to Eastern Kentucky schools in May of 1968 tended to reduce markedly a skepticism toward the brief lessons.[68]

In addition, they characterized the users as business-like in signing on, and lacking patience to wait for terminal space to become available. Further, they noted that the enthusiasm did not tend to diminish over time, thus discounting the Hawthorne effect (novelty) as a primary motivator in the early stages of usage.

This generally positive aura did not eliminate entirely the factors of emotionality and anxiety. Smith and Pohland noted that "extreme nervousness and self-consciousness occurred frequently."[69] Most commonly, this resulted from the child's own performance expectations (keeping up with the computer), desire to conceal performance from others, and exhaustion, particularly in slower students who spent the longest amount of time to complete drills.

Another phenomenon that Smith and Pohland noted was animism, a tendency of the children to have verbal interactions with the computer as they worked the drills. Sometimes this verbalization included self-critism of the child's own performance.

A more serious occurrence is subsumed under the heading social dimensions and refers to the frequent group activity at the computer.

In Smith and Pohland's estimation, this group activity can sometimes be authorized and/or necessary, as when children are initially introduced to the use of CAI. Frequently it is not, however, and in many instances help is given whether it is requested or not. This raises serious questions about CAI as a format designed for individualization, and tends to invalidate to some extent the achievement scores attained by children when their work may have been fed to the computer pre-corrected.

Another issue in CAI usage in Eastern Kentucky is competition. The pupils on the whole were highly competitive, and Smith and Pohland were able to identify four separate types of inter-pupil competition.

(1) Greatest number of drills per day

(2) Shortest completion time for one drill

(3) Highest score per drill

(4) Combination of score and time

The children seemed on the whole to feel comfortable comparing computer print-outs, and did so frequently.

Smith and Pohland's final observations about CAI users, design and supervision, are indirectly related to the subject at hand. They noted problems in terminal design, especially for primary school children who often had to stand up instead of sitting in order to utilize terminals comfortably. While this is not strictly speaking a user reaction to the instructional material, the lack of well-designed terminals would certainly seem to affect the child's reaction to the situation. Secondly, the authors noted a need for more adequate supervision to deal with problems ranging from computer errors to unauthorized group activity, a recommendation fitting into this broad

area, but not directly a part of user reaction either. It's effect on the user, particularly in making the data more reliable by eliminating group activity, seems to be a serious issue.

With the serious and frequent shut-downs and technical difficulties that were an integral part of the Eastern Kentucky project, the users' basic acceptance of and enthusiasm for CAI seems very significant, moreso than if acceptance and enthusiasm were achieved under optimum conditions.

VIII. THE IMPACT OF THE INNOVATION: EVALUATION

Introduction

Computer-assisted instruction has received a great deal of publicity in the last fifteen years. Its proponents bill it as the most important educational frontier opening up today. While CAI has demonstrated some positive effects, notably its apparent success in raising the achievement scores among children who are not performing at grade expectancy levels,[70] it must be viewed as an innovation which has received limited acceptance at this time.

Accurate figures on the number of students actually exposed to CAI are not available. Among school systems which have adopted CAI, the Chicago and Philadelphia public school systems are probably the largest. In Philadelphia, by 1973, 11,000 students at all levels were using CAI[71] and during the same year, there were 7,000 students learning reading and either mathematics or language art skills through CAI in Chicago.[72] In late 1974, Dr. Suppes estimated the number of students using Computer Curriculum Corporation's materials at 25,000.[73]

As a means of gauging the degree of penetration of computer-assisted instruction among the nation's elementary-level school population, a "guesstimated" figure of 100,000 CAI users will be used. Although firm data to support this estimate is lacking, the 100,000 figure should represent an upper bound to the number of

elementary school students using CAI and will suffice for the following comparison. The 1974 Statistical Abstract of the United States, has determined that in the school year 1972-73, 34.6 million students were enrolled in both public and private elementary schools (grades 1-8) in the United States.[74] Therefore, it is estimated that only 0.29% of the elementary aged students in this country are currently using computer-assisted instruction.

Fears About CAI

In the introduction to their book about the 1966-68 arithmetic programs, Suppes and Morningstar identify and discuss four common fears that have arisen regarding computer-assisted instruction.[75] The first, depersonalization, is the fear that students will be deprived of necessary human interaction by excessive reliance of the educational system on computers for instruction. The second, excessive standardization, seems to result from the general observation that in most subjects that are routinely a part of educational programs there is already a high degree of standardization of material, and the fear is that computer-assisted instruction will further intensify this situation.

Thirdly, there is a fear of simple-minded curriculum, which rests on the fact that programmed instruction, the theoretical foundation of drill and practice CAI, suffered in many instances from poor construction that led to just such simple-mindedness. The final fear is that human freedom will succumb to domination by "thinking" machines, as typified by computers with instructional capacity. While Suppes and Morningstar concede the possibility of these four fears being realized as the result of human mismanagement of computer

capabilities, they assert that the positive potential of the computer in education is to do the reverse.

Suppes and Morningstar further assert that computers have the capacity, with proper human input, to offer extremely personalized and individualized instruction; to offer extremely rich and varied learning programs; to encourage the development of more well-constructed curriculum by virtue of their feedback capacities; and to allow more human freedom by eliminating the necessity for humans to do boring or tiresome routine tasks like the compilation of data.

While these issues became the subject of great debate in the public forum, by and large they have not been the problems encountered by the adopters of computer-assisted instruction in day-to-day acitvities, but seem, rather, to be philosophical considerations.

Operational Problems

In the real world of CAI usage, perhaps the most serious operational problems have been reliability of the physical plant (hardware) and cost. Particularly among the reports about the first-generation projects like the Grant School project (1965),[76] the McComb, Mississippi project (1967),[77] and the Eastern Kentucky Educational Development Center's project (1967),[78] the recitals of technical difficulties are long and frustrating.

At Grant School, for example, the orders were placed in July, 1965 for equipment which was to be operational by September 1st, 1965. It finally began operating on October 18th, 1965, and not without frequent breakdowns. In the Eastern Kentucky project, the system was inoperational for one period of three months because of changes in the computer (from a PDP-1 to a PDP-10) going on at the Stanford

Campus. Ascher Opler, in "The Receding Future," as reported by Pohland and Smith, sums up these experiences in the following way"

> The history of the development of computer hardware, software, and application has been characterized by (1) lateness, (2) rescheduling, (3) cliff-hanging finales, (4) substitutions of interim versions for promised ones, (5) the substitution of a "Phase 1" goal for the full goal, or (6) the on-time delivery of the promised system in a version whose quality and reliability were too poor to allow system usage....[79]

Pohland and Smith, in 1971, characterized computers as "the prima donnas of educational technology. They require more support services and special facilities than do other technological innovations. The difficulties of maintaining CAI systems are somewhat minimized only where highly trained - and costly - technicians are available."[80]

As reported in Section IV of this study, however, second and third generation programs seem to have benefitted from the experiences gained during the trying early years. Computer Curriculum Corporation, with its small, self-contained computer systems, has a record of technical reliability that seemed difficult to achieve in earlier, first generation systems.

The economics of computer-assisted instruction, while still high, have improved tremendously also. During the second year of operation, the Eastern Kentucky project cost $258,000, or $8600 per terminal.[81] At twenty-five students per terminal that would be $344 per student per year. A 1969 estimate of the cost of the initial outlay for a CAI program serving 100,000 pupils in a school district where each student used the computer one hour per day for 150 days per year

was $27.2 million.* In McComb, Mississippi, however, initial costs were reduced significantly each year in three reported years, going from $700 per student, to $143 per student, to $25-$35 per student per year, with a goal of four to five dollars per student per year.[82]

The expensiveness of CAI systems has led to a number of proposals for reducing costs. J. D. Prince, director of the McComb, Mississippi project, asserted that "for CAI to be delivered at a reasonable cost, it must be delivered by a computer system that has more than one purpose and has no easily reached finite limitation on the number of pupils served."[83] Grayson, author of "A Paradox: The Promises and Pitfalls of CAI," believes that by achieving a compromise between local autonomy and some program standardization, acceptable levels of quality and economy can be obtained.[84]

One final word of caution is directed by Atkinson and Wilson at those whose criticisms in the late 1960's were aimed primarily at technical aspects of CAI:

> At a more intuitive level it must be clearly understood that evaluation of a computer-assisted instruction program is only partially an evaluation of the system and equipment. Primarily it is an evaluation of the instructional program and as such is basically an evaluation of the program designer who is the real teacher in a computer-assisted instruction system.[85]

Attitudinal Problems

The economic and technical problems encountered during the development of CAI are not the only stumbling blocks to its usage.

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*It should be noted here, however, that the Stanford material was designed to be used for much shorter daily periods by students, approximately five to fifteen minutes per day, which would increase the student capacity at least by a factor of four, and perhaps by a factor of twelve, substantially reducing the cost per student per year.

Attitudes, particularly of the teachers whose students are potential or actual users, are recognized to be of crucial importance to successful adoption and implementation of computer-assisted instruction. Grayson has stated that "If CAI is to become widely adopted, a change in teacher attitudes will have to occur."[86]

In part, those attitudes are general, and have negative implications for any innovation in school routine. Both Pohland and Smith, as well as Suppes, have commented on rigid attitudes and reluctance to relinquish control of their classrooms on the part of some teachers. According to Pohland and Smith:

> Schools are stable institutions with well-established patterns of behavior. Resistance to change is typical, including resistance to new kinds of teaching equipment... In addition to resisting changes in instructional technology, teachers are even more unwilling to lose the autonomy afforded by their self-contained classrooms.[87]

Similarly, Dr. Suppes defines the phenomenon thus: "The teachers run an empire, and CAI is a psychological invasion of that empire."[88]

However, Dr. Suppes goes one step further in his consideration of teacher resistance as related specifically to computer-assisted instruction. He feels that because some elementary teachers themselves feel insecure about their grasp of mathematics, that they tend to emphasize drill-and-practice in their own teaching rather than stressing concept formation. The consequences of this frequently are to make such teachers resistant to educational innovations that they feel will point out their own inadequacies.[89]

On the other hand, teachers who feel inadequate in the mathematical arena may use the drill-and-practice in a tutorial way, to teach skills, rather than in the supplemental way that the program

was intended, becoming less concerned about teaching mathematics themselves to their students.

It is clear, therefore, that in addition to sharply increasing their technological and economic performance, CAI must also attempt to overcome prejudices and fears in individual teachers who may inadvertantly misuse CAI. The fact that some of these fears may be well-founded means perhaps looking for new ways to approach utilization of CAI.

CAI's Impact on Education

Perhaps the single most important potential of CAI on the American educational system would be its claimed ability to provide highly individualized instruction while freeing the teacher of routine drill-and-practice, and to open up corridors for the expansion of curriculum. Suppes and Morningstar have concluded:

> This possibility of bringing enriched programs to students in a variety of environments where such courses cannot reasonably be offered by the teaching staff, either because of lack of time or because of lack of training, is probably one of the most immediately practical aspects of computer-assisted instruction.[90]

At the same time, Jamison, Suppes, and Wells, in their survey of instructional media, made this charge to the educational system:

> In short, the educational system should be attempting to improve productivity in its established activities in order to be able to undertake successfully the new tasks society is asking of it.[91]

If CAI has the capacity to improve educational productivity that its proponents claim, and if, as Jamison, Suppes, and Wells assert, the educational system must improve productivity then the question must be answered, "Why is CAI being utilized to such a limited extent?"

As seen earlier in this Section, the three greatest impediments to full utilization of CAI have been (1) cost; (2) reliability of the computer system; and (3) resistance of school personnel (adopters). Cost is by far the most serious problem, and the reader is referred to previous remarks in this study concerning the cost of computer-assisted instruction. In order to be more fully utilized, CAI expenses must either be reduced to approximate or go below the cost of traditionally administered instruction, or CAI must be utilized in a way that would cut other educational expenses. For instance, if CAI can teach the same material in a shorter period of time than traditional instruction, as Jamison, Suppes, and Wells conclude, that may enhance its cost/effectiveness, but only if changes are made in the educational system to capitalize on that time reduction, such as decreasing the amount of years devoted to schooling, or increasing the student/teacher ratio. According to Jamison, Suppes, and Wells: "There are no examples yet of CAI being introduced with a concomitant change in student-teacher ratio, which would for example, cover the costs of CAI.[92]

This reopens consideration of resistance of school personnel to CAI. The extent to which CAI is perceived as a threat to the status quo will have an effect on its adoption. CAI does challenge biases that some people have about education, particularly the assumption that children need the interpersonal interaction provided by the traditional classroom setting in order to learn socialization skills.

A more serious resistance to CAI stems from the perceived threat to teaching jobs, especially at a time when there seems to be an overabundance of classroom teachers. The unionization of teachers in the last few decades has given them ample power to affect the

educational system, and this factor must be considered seriously. Computer-assisted instruction may function more cost/effectively by reducing the need for classroom teachers, and that is likely to engender strong anti-CAI sentiments.

Not only do teachers have a stake in maintaining the status quo. Parents of students and students themselves are biased in favor of traditionally administered education. In response to attudinal questionnaires administered by Suppes et al, it was found that maintaining the teacher's traditional role is important to parents and students using CAI.[93]

The last factor in utilization of CAI, technical reliability may be the least serious. Improvements in the computer field over the last three decades, as shown in Section IV, have been major, and the continued technical refinement of computer capabilities can be expected to continue, positively affecting the delivery of CAI.

CAI's Impact on Students

It has been indicated in the preceeding Sections that computer assisted drill-and-practice can have positive effects on the scholastic achievements of elementary students. Vinsonhaler and Bass,[94] Jamison, Suppes, and Wells;[95] and Charp[96] among others, have noted this effect. It should also be noted that this opinion is not unanimous, and that even researchers like Jamison, Suppes, and Wells, whose basic evaluation is positive, have included caveats.

In particular, CAI seems to offer greater benefits for students who, for one reason or another, have not been able to meet grade level expectations, especially "disadvantaged" students. J. D. Prince has

analyzed an experiment in the McComb, Mississippi schools reported in Section VII, and reports the following conclusion:

> The particular finding (which is replicated throughout our statistical results at other grade levels) is an indication that CAI may well be a technique suited for closing the educational gap which exists between the disadvantaged and children from more affluent segments of society.[97]

Feldman and Sears, in an independent study, noted marked positive changes in the academic behavior of children who participated in a CAI program for one year, as compared to a matched group of children who did not receive CAI, which is attributed to the lack of prejudicial or judgmental attitudes about the child's non-academic behavior that, in traditional education, is sometimes demonstrated by the teacher. "What appears to have happened is that a child's classroom behavior had less to do with his achievement in the subject in which CAI instruction was given than is normally the case."[98]

Further investigation of this finding may show that some correlation between academic achievement and teacher expectations, as referred to above, is operative in the lower educational achievements by disadvantaged children. If, as evidence suggests, teachers have lower expectations for disadvantaged children than for middleclass children, the substitution of non-judgmental CAI instruction could well benefit disadvantaged children significantly.

Requirements for Improved CAI Adoption

If computer-assisted instruction is to be adopted on a more widespread basis, it will have to meet three requirements:

(1) cost/effectiveness

(2) proven educational efficacy

(3) protection of adopters' and users' interests

The role of cost/effectiveness in CAI adoption or non-adoption has been considered to some extent in this investigation, and, except for a reiteration of its extreme importance, that aspect of development will not be reopened. As regards the educational efficacy of CAI, it is necessary that more serious efforts to resolve the question of demonstrable educational benefits of CAI for students be undertaken if the potential adopter is expected to become an actual adopter. One way of resolving that question is through additional well-controlled comparative studies of the achievement levels among students exposed to CAI or to traditional instruction.

Thirdly, to maximize adoption of CAI, developers must protect as much as possible the interests of the adopters and the users. As noted previously in this study, Smith and Pohland found that R & D requirements sometimes varied markedly from commercial use requirements, and the difficulties encountered by adopters and users in CAI's earlier history may make them skeptical of trying such programs in the future without additional assurances of reliability and continuity of service.

This factor of assurance may be more essential in communities where much of the schools' financial support is federal (i. e. poor urban and rural areas) because sustained support for innovations, or long-range innovative commitments have frequently been missing there.

In order to study and implement these requirements, the available information on CAI activities should be upgraded. Much of the literature is fragmentary, and in addition, most of it refers to research-oriented projects and not regularly-used, non-research

applications. Dr. Suppes has attributed this to the reluctance of educators and administrators in those schools using CAI on a regular basis to make data on school performance generally available.[99] What is needed is a survey of the major CAI programs, both research-oriented and commercial, so that accurate conclusions about the current state of the art will be more readily available in the future.

IX. SUMMARY ANALYSIS

The University as Entrepreneur

It is the opinion of Patrick Suppes, director of the Institute for Mathematical Studies in the Social Sciences at Stanford University, that "the last home of the entrepreneur is the university."[100] Research oriented universities solicit funding from various sources, piecing the monies together, in order to carry out experimental programs. They are not constrained by the need to make profits, or pay dividends, as businesses are, and therefore have the freedom to pursue investigations that may not provide immediate returns on the investment. Jamison, Suppes, and Wells have noted the stimulus which research-based universities have been to the development of computer-assisted instruction in general.[101]

The drawbacks of such R & D orientation, pointed out by Smith and Pohland, should not be overlooked, however. The fact that developmental programs are frequently in a state of flux alone accounts for many of the adopter-perceived difficulties, such as changes in software format, changing in scheduling, and shutdowns caused by changes in hardware. In addition, the reliance on outside funding may cause delays or changes in plans for the adopters due to uncertainty about the amount of the final contract or the release of the funds for use. The difficulties encountered in the Eastern Kentucky Educational Development Center's CAI project highlight this issue.[102]

In the original development and dissemination of computer-assisted instruction, the entrepreneurial function as exemplified by Patrick Suppes and Richard Atkinson was one of the chief elements. The decision of Suppes and Atkinson to utilize computer-based instruction as the vehicle for operating a laboratory for the investigation of more complex learning stands out clearly as the origin of CAI experimentation in elementary education. Their decision had two goals: (1) to provide an interactive mode of education, particularly to facilitate the compilation of data for research, and (2) to obtain complete control over the experimental environment, particularly the material presented to the students.[103]

The continuation of this research since 1962 is evidence of the Institute's resourcefulness in obtaining funding. One way that ongoing support was maintained was by staying closely attuned to the changes in priorities in federal educational policy. The original complex-learning laboratory concept was modified to include the Stanford-Brentwood Computer-Assisted Instruction Laboratory in 1964 when the United States Office of Education funding to establish an ongoing investigation of CAI in a public school became available.

The concern of educators and legislators with rectifying inequities in the educational system, as evidenced by the Elementary and Secondary Education Act of 1965, opened up funding in compensatory education, and signalled a shift in that direction by the Institute, particularly in its Mississippi and Kentucky projects. Current interests have been in the education of handicapped children and this has generated research at the Institute in the application of CAI for deaf students. The realignment of research-orientation to public

policy can be seen as a contributory factor to the creative and diverse nature of the research at the Institute for Mathematical Studies in the Social Sciences.

Although the National Science Foundation, U.S. Office of Education, and ESEA provided funding, both to the Institute and to the individual schools which participated in Institute projects, they did not control the research activities of the Institute. It has been noted earlier in this report that there was no central policy or plan on the part of federal educational agencies to promote computer-assisted instruction. Their role, in Dr. Suppes eyes, was to act as marriage brokers; that is, to initiate contacts between the Institute and those school systems with complementary goals.

Another contributing factor that is closely intertwined with the Institute's recognition of shifting priorities in American educational interests was its utilization of feedback from the adopters in assessing its operations. The financial difficulties of funding the operation of expensive tutorial computer-assisted instruction led to the development of drill-and-practice formats, which are considerably more economical. The financial and technical problems caused by reliance on longlines and remote teletype terminals led to the development of self-contained computer systems. Once again, flexibility on the part of the initiators was significant in the development of the operation.

Commercial CAI

For the very reason that research-oriented universities like Stanford are not compelled to produce a profitable, marketable

product, the full extent of the Institute's achievements can not be measured by its research achievements. Computer Curriculum Corporation, the private, commercial CAI company established in 1967, under the direction of Patrick Suppes, reflects an added dimension of the research originated at Stanford University.

Too often, the erudite theories and concepts developed in institutions of higher learning fail to make significant contributions in real-world applications. The expanding utilization of CCC's computer-assisted instructional software and self-contained computer hardware demonstrates that the transition of computer-assisted instruction from theory to reality is possible. From a few thousand students using an experimentally unfinished product, CAI application has increased until it is being used by a "guesstimated" upper bound of 100,000 students as an educational aid. However, as noted in Section VIII, this number represents 0.29% of total elementary student population, and must be increased tremendously before CAI can be deemed to have become a widely adopted innovation.

Patrick Suppes, as director of the Institute for Mathematical Studies in the Social Sciences and president of Computer Curriculum Corporation, has played an active role in the development of CAI. It has been a generally noted phenomenon, particularly in the 1960's when research was well-supported financially, that there was a proliferation of private companies incorporated by members of university research teams to commercialize the results of their research activities. This dual role in experimental and commercial endeavor can be seen as an asset to utilization and implementation of CAI capabilities.

Conclusion

In summary, the development of computer-assisted instruction for elementary education at the Institute for Mathematical Studies in the Social Sciences at Stanford University represents the fortuitous interface of changing educational priorities, farsighted and dynamic leadership at a research institution, and available financial resources.

It would be a mistake, however, to credit sheer good fortune with this achievement. While the interest and leadership of particular individuals in the innovation may have been chance, the climate of growth surrounding the innovation resulted from readily definable conditions, including pressure on educators to develop new teaching techniques to improve the reading and mathematical skills of American children; the interest of agencies such as the National Institute of Education, the National Science Foundation, and the U.S. Office of Education; and the broad availability of government funds for research in many areas, including education and computer science, at that time. In attempting to nurture similarly innovative ideas, policymakers can be effective by promoting an atmosphere of support, both financial and ideological, that will encourage research and development, thus increasing the possibilities that individuals and research institutions will venture into untried waters.

As an experimental program, CAI has been relatively effective (i.e. has demonstrated the potential benefits and applications of CAI), but has not yet demonstrated its ability to adequately make the transition from experimental to real-world utilization. This is shown in the small percentage of actual users as compared to the large number of potential users.

The reasons that the number of actual users is so small are fourfold. First, the costs of CAI remain high. Secondly, adopters must rely on the availability of outside funding and/or divert their own available funds from other uses to CAI. The third reason is the resistance among adopters, particularly teachers who have considerable power to sway administrative decisions through their labor unions. Finally, inconclusive data on CAI's superiority to other methods of instruction, compounded by cost inhibitions, adds a significant element of doubt in adoption decisions.

CAI, while offering potentially great benefits in education, must be considered at this writing to be having very limited impact on education as it is delivered to the typical student in the average school setting.

Financial considerations appear to be a key point at which CAI fails to measure up to expectations or needs. With significant reductions in the expense of CAI to a level on the par with or below the costs of other educational methods, particularly traditional instruction, CAI can be expected to be utilized more and more. Without such reductions, CAI will probably be relegated to historical obscurity in the educational scene, unless traditional instructional costs increase to the point that they are equally expensive. If CAI can be shown to be cost-effective, the other problems regarding its adoption could significantly decrease.

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CHAPTER 4: COMPARATIVE ANALYSIS; ISSUES AND POLICY IMPLICATIONS; FUTURE RESEARCH

The previous case studies have examined in some detail the history and development of two educational innovations, namely 1) "Sesame Street" developed by The Children's Television Workshop and 2) CAI for elementary education created at the Institute for Mathematical Studies in the Social Sciences (IMSSS) at Stanford University. An analysis of the innovation process for each of these cases has been presented and issues raised which should prove useful to educational policymakers. In this section, a comparative analysis has been carried out between the two cases in an attempt to gain additional insight into the process of innovation in education. The section also examines policy implications of the case studies and makes recommendations for further research.

I. COMPARATIVE ANALYSIS OF THE "SESAME STREET" AND "IMSSS-CAI" CASES

A. Introduction

A comparison of the "Sesame Street" and "IMSSS-CAI" cases might best begin by pointing out some of the limitations of such an analysis. In a sense, the dissimilarity of the two cases might result in a comparison of the proverbial apples and oranges. "Sesame Street", although it brought television technology into the teaching of cognitive skills to a far greater extent than any previous effort, seems much less of a technological innovation than CAI. The latter perhaps was closer in many ways to being an invention and the CAI case study focuses heavily on the research and development stage in contrast with the more production or "operational" nature of "Sesame Street". Another limitation concerns availability of information. In general, there was more information and analyses available on "Sesame Street" than on the CAI case in question. The results are not really "all

in" on CAI to the extent that they appear to be on "Sesame Street". The CAI case study was heavily dependent upon information from and analyses performed by the initiators, and time and resources did not permit a more in-depth investigation. With these limitations in mind, we proceed with the analysis.

B. Acceptance of the Innovation

As indicated in Chapters 2 and 3, the "Sesame Street" innovation has been far more widely accepted to date than CAI. There are many reasons to explain this fact, and several frameworks within the study of innovation to base such explanations on. One useful classification makes the distinction between "ancillary" and "mainline" innovations. A mainline innovation is one which will, if adopted, tend to produce substantive alterations in the adopting system as that mechanism accommodates itself to incorporate the change. An ancillary innovation is one which will produce a far more negligible alteration within its adopting system since the necessary accommodation is of a lesser magnitude. The logical conclusion is that ancillary innovations will be more readily accepted than mainline innovations.(1)

By considering "Sesame Street" an ancillary innovation and the IMSSS-CAI a mainline innovation, we have a convenient rubric to explain their different degrees of acceptance. "Sesame Street" circumvented the schools, which have not been among the most receptive institutions to the intrusion of technology, and relied upon the commonly-available medium of open-circuit television to reach its pre-school aged users. The adopting system in this case was not the schools but the non-commercial broadcasting establishment which, because of its fledgling status, was generally willing to try the innovation. The degree of accommodation centered around clearances,

or the ability of local stations to reschedule other broadcast commitments and free the morning time period desired by the CTW for airing the show. As Chapter 2 has pointed out, this was able to be arranged in even the biggest broadcast markets housing most of the user population, where it was deemed the most essential.

The IMSSS was attempting to reach a school-aged user population with a new curricular format which was predicated upon computers, an instructional technology new to the elementary school level. Some school districts proved willing to try the innovation, but the degree of accommodation required was substantial. In some cases, physical refurbishments were necessary to accommodate computer terminals; operational rescheduling was required; new layers of personnel were needed; and reliance upon external factors, such as telephone longlines and timely servicing, was heavy and crucial. Although IMSSS-CAI switched to small, decentralized computers in the commercial version now marketed by Computer Curriculum Corporation, reducing some of the technical problems, the direct injection of computer terminals in the schools to be used either to substitute for or supplement teacher activity can be interpreted as representing a mainline innovation--hence the relatively limited acceptance.

Another framework which might be used for analyzing the acceptance of an innovation is that which presents characteristics considered to be of importance in explaining the rate of adoption of an innovation. These include:[2]

Relative Advantage - the degree to which an innovation is perceived as being better than the one it supercedes.

Observability - the degree to which the results of an innovation are visible to others.

Compatibility - the degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of the receivers.

Complexity - the degree to which an innovation is perceived as difficult to understand and use.

Trialability - the degree to which an innovation may be experimented with on a limited basis. An innovation which is trialable generally represents less risk to the individual who is considering it.

Using these criteria, it would appear that "Sesame Street" would score definitely higher than "IMSSS-CAI" in terms of at least three of these characteristics, namely observability, compatibility and (lack of) complexity. Relative advantage and trialability are probably more difficult to analyze. Overall, the outcome of the acceptance of these two innovations would seem to be in line with these criteria.

C. The Delivery System

There are other reasons to explain the differences in acceptance of these innovations. "Sesame Street" could be tried on a nationwide scale, giving it a visibility denied to the school-by-school trials of the IMSSS-CAI curricula. An important factor here was the physical or technological delivery system. Television networks gird the United States. By having access to the interconnection of the non-commercial television stations, "Sesame Street" had the potential for reaching 70 percent of its intended audience on the day of its premiere in 1969*. By contrast, during the

*This potential coverage could have been even greater had the show debuted over one of the three commercial television networks which were far more developed. However, this was not to be the case, as discussed in Chapter 2.

late 1960's, no time-shared educational computer networks girded the country. For the IMSSS-CAI to reach its intended users, dissemination of new hardware had to take place essentially on a site-by-site, i.e. school-by-school basis. The technological infrastructure for wide diffusion did not exist.

D. The Initiating Units: Organizational Features

The Children's Television Workshop, the initiating unit for "Sesame Street" is a private organization which was created specifically to develop the innovation. In a sense, it represents an organizational innovation in itself. Although CTW functioned as a production house as the term is commonly understood within the milieu of the broadcast industry, its internal organization was such that the Workshop was not just another "kidvid" producer. CTW operations were based upon the combination of pedagogic research and broadcast production expertise. Operations were geared to the feedback between the two professional groups with resultant production reflective of the interaction. Having in-house research design capability gave CTW stature within academia and the public and private funding communities; this posture was enhanced by expansion to include external evaluation of the target audience so that the instructional impact of "Sesame Street" could be verified.

It must be underscored that despite these important and original features of CTW, the organization operated in a sense within an established industry, the broadcast industry, where standards of production and methods of distribution were available as guidelines. The format of the innovation, an hour-long television program for a specified target audience, was already an accepted one with potential adopters (any of the three commercial networks or the non-commercial interconnection) and users. Unlike the

concern of the funding community for a heuristic design, the concern of potential network adopters would center on the show's production quality to insure its ability to compete against the dominant mode of entertainment programming. Due to the fact that they faced an oligopsonistic broadcast market structure, CTW quickly adopted this conventional wisdom to better its chances of gaining access to the airwaves.

The Institute for Mathematical Studies in the Social Sciences is a university-based research organization. In the course of its research, the IMSSS developed computer-assisted instruction curricula which were regarded as applicable to elementary classrooms. Unlike CTW, the IMSSS was geared solely to research and development. It was not organized to deliver a finished product to users on a regular basis. The transition from R & D to routine production can be a difficult one which follows different paths. Since both the technology and its instructional applications were so relatively new, there existed no established industry practices to guide production and diffusion. Dr. Suppes subsequently chose the "Route 128" path by starting a private enterprise, The Computer Curriculum Corporation, to deliver a decentralized form of CAI to the labyrinthine educational market. Other CAI systems are currently under development at the University of Illinois (PLATO-IV) and the Mitre Corporation (TICCIT) which in a sense are or may be competitors in this market.

E. Methods of Financing the Innovations

Both "Sesame Street" and IMSSS-CAI received funds from private foundations and public sources; approximately half of "Sesame Street's" initial financing came from federal sources while, to the best of our knowledge, an even greater proportion of the monies for the IMSSS-CAI stemmed from the public sector. However, a more crucial distinction can

be made concerning the nature of the public funding which relates to the problems of obtaining sustained rather than piecemeal support for a sufficient period at a sufficient level.

In the case of "Sesame Street," federal funding sources were centralized in the Commissioner's Office of the Office of Education. Other Department of Health, Education, and Welfare agencies contributed, but the Commissioner's Office was willing and able to act as the disbursal agent. This freed CTW executives from the complexities of dealing with many parties over prolonged periods to arrange financial compromises. Additionally, support might be viewed as being obtained for a "project related" rather than "bookkeeping" period of time; the original level of federal support, reputedly within the generous ballpark of $4 million, was for an 18 month period spanning the research-production-dissemination cycle. Furthermore, it should be noted that funding for the program was not umbilically tied to specific legislative titles which were highly sensitive to the fluctuations of annual appropriations. Non-commercial television station adopters were also supported in part by federal funds. This support was, to the best of our knowledge, separate from the financing of the "Sesame Street" innovation and was based on legislation specifically designed to improve and expand non-commercial broadcasting facilities and organization.

The situation appears to be almost the reverse for the IMSSS-CAI. Although developmental efforts had been supported by a number of agencies, adoption was financed primarily by the Office of Education acting under various titles of the omnibus Elementary and Secondary Education Act of 1965. This funding mechanism appears to have been susceptible to the viscissitudes of annual appropriations. Disbursal was scattered rather than centralized. Individual schools with Title I funds could theoretically

decide which projects to support, with CAI projects being just one option. However, there may have been some effort on the part of intermediaries to match IMSSS-CAI with relevant local projects using ESEA Title III funds so that the compensatory properties attributed to the innovation could be measured. This is an aspect of the CAI case study which might receive additional attention. The situation became even more complex in 1967, with the passage of the Green Amendment, when state education agencies were required to act as disbursal agencies for ESEA funds within their states. Each year adopting school districts were required to compete against other districts for a slice of the ESEA pie. As a result of all this, the initiating unit had to expend valuable energy to deal with a number of parties over prolonged periods to arrange for necessary adoption and financing. The decision to create a private enterprise, the Computer Curriculum Corporation, as the mechanism to spur adoption by school districts may have developed from this situation.

F. The Role of Government

The role of government vis-a-vis education in the public service sector is a subject of considerable current interest. The federal role in both the "Sesame Street" and CAI cases was of considerable importance. Federal funds were provided to support both innovations but in somewhat different ways, as was described in the preceding sub-section.

The point has also been made previously that the physical delivery system for "Sesame Street," namely public broadcasting, permitted rapid and widespread dissemination. That system is itself financed heavily through public funds. Had public broadcasting not been in existence and had the commercial networks still been reluctant to adopt "Sesame Street," the outcome could have been far different. This is not to say that the private sector and private initiative, through such individuals as Lloyd Morrisett

of the Carnegie Foundation did not play a key role. But it would appear that the government role, both indirectly as well as directly, was substantial.

In a sense, the diffusion path chosen by Dr. Suppes, from university R & D to private industry to the schools, is a more conventional one in the U.S. than for "Sesame Street." The federal input lacking in the CAI case is that of a federally supported operational dissemination network. It's not inconceivable that some day public broadcasting will become public telecommunications, with media other than television and radio such as CAI becoming commonplace. This was not the situation which IMSSS-CAI confronted.

In the "Sesame Street" case, there were individuals in the federal government such as Harold Howe, former Commissioner of Education, and his aide Louis Hausman who were able to help things along in more than just financial ways. There appears to be no parallel documentation of the early experiences with CAI enabling exploration of the interaction between individuals in the federal government and the initiating unit.

Some strategies which have been employed by government to promote the adoption of an innovation have been analyzed by Utech and Utech.(1) In their brief pilot study of how knowledge of and news about technological innovations travel from one local jurisdiction to another, it was concluded that federally sponsored efforts such as demonstration projects, market aggregation and creating greater awareness are limited in value for promoting innovations. There is no strong grapevine apparent for communication between local units in the education field and both teachers and administrators both lack reliable evaluation of the merits of innovations. Such would appear to be the case with IMSSS-CAI. According to this same study,

private and federal efforts to promote educational innovation by full-scale demonstration projects in chosen school districts have not yielded hoped for results and this demonstration strategy is being modified or abandoned. However, such demonstrations do create awareness of the innovations. The report concludes that more extensive training programs associated with innovations would be a positive federal contribution.

II. SOME OBSERVATIONS AND ISSUES CONCERNING THE INNOVATION PROCESS

The previous comparative analysis has emphasized differences between two case studies of innovation in education. While there also are some similarities which permit some generalizations to be made, (albeit on only two data points!), we have also become acutely aware of new questions raised by the cases. Accordingly, in this section, further observations are made and issues raised concerning the innovation.

A. The Mutability of Innovations

Relying once again upon the phraseology of innovation studies, the cases examined have revealed the presence of the "mutation phenomenon," in which variability in how institutions respond to an innovation brings about changes in the innovation itself, as adopted in various settings.(3) The presence of this phenomenon in both case studies is interesting because its effects have generally been observed in instances where schools have served as adopters.

The presence of this phenomenon in the two case studies has been documented in Chapters 2 and 3 and will not be discussed further. We do suggest, however, that despite the modifications made in each innovation as it progressed from drawingboard to use, what finally emerged was still a television program and a computer-assisted curriculum. Indeed, the notion that a technologically-based innovation does not shed its technological

character may be a distinguishing feature of these two cases. By contrast, it may be that programmatic or procedural innovations are more malleable, which may go far towards explaining the greater acceptance of such innovations in schools.

B. The Importance of the Entrepreneur

We have used the terms "innovator" and "entrepreneur" interchangeably, given the examples under consideration. Both case studies are replete with examples of the cruciality of this element. Although we are unable to produce a check-list of qualities an entrepreneur should possess, this individual or group of people assume a high level of importance for an innovation because of the motivation and direction they provide to the change process. The innovator, generally more so than any other actor in the innovation scenario, is sufficiently motivated to see the process through and the innovation adopted to some degree. Since much anxiety may be expended in the process, we feel this indicates a sense of mission which in turn provides much of the momentum necessary for the change cycle to go to completion.

The entrepreneur supplies a sense of direction to the innovation process not only by his or her sustained presence but also through her or his ability to make and respond to critical decisions. As noted in the Summary Analysis of Chapter 2, ranking CTW executives responded to suggestions that production values be upgraded and that an external research component be included. The final section of Chapter 3 notes the flexibility of IMSSS leadership in locating CAI demonstrations during the late 1960's, and the subsequent decision to diffuse the innovation via the private sector. We cite these instances again to indicate that the ability to make decisions or accommodate good suggestions is an important

entrepreneurial quality which in turn affects the innovation process. We note also that by acting in this fashion, the innovator was exercising his or her best judgment regarding the best interests of the innovation; therefore, although a quality of flexibility was shown, the emphasis was actually upon keeping control of the change process through reasoned response to new conditions.

Finally, we note with interest that in each case the key innovators were not government officials but were professionally-experienced individuals with access to qualified and interested people from other circles, or those circles necessary to penetrate if an innovation process were to ensue. Thus we have two situations in which an innovation was carved from a particular environment by entrepreneurs acting to a considerable extent on their own perceptions rather than by policy makers. The innovation process does not seem to follow a neat sequence in which a problem is defined, alternatives to solve the problem are proposed and a choice made. In the IMSSS-CAI case, the interests and inventiveness of research oriented innovators were probably the driving force, with funding preferences perhaps helping to steer choices. In the CTW-"Sesame Street" case, concerned individuals were motivated to try to redress a situation being perceived as less than optimal by bringing about major improvements in a medium that they felt was being used far below its potential.

C. On Reaching the Users

The two case studies would seem to uphold the contention that utilization of electronic technology for instructional purposes is more likely in an out-of-school environment or non-traditional educational setting. However, this may not necessarily be the case in the long run. "Sesame Street" may have in fact served as a "gateway innovation"(4) which

enabled the next CTW production, "The Electric Company" to be more readily accepted for in-school viewing. Here, the target audience, in contrast to the pre-school "Sesame Street" viewers, was students of school age. Within a season of its debut, "The Electric Company" had achieved the highest in-school penetration rate of any instructional television program.

The much lower rate of acceptance of IMSSS-CAI in the schools may be attributable to issues of cost-effectiveness, lack of familiarity and of physical delivery systems--and not primarily to the fact that the schools were the adopters. It is conceivable that CTW television programs will serve as the gateway innovation for the in-school instructional technology of tomorrow, including CAI, in spite of differences in how each innovation is currently perceived by both users and schools.

D. On Cost-Effectiveness and Productivity

The concepts of "cost-effectiveness" and "productivity" to varying degrees figure in the thinking of policymakers dealing with innovation in education. These concepts are concerned generally with the extent to which educational outputs are achieved for a given set of inputs. They are borrowed from industrial economics and have been modified for use in the field of education. Both concepts deal to some extent with economic costs.

The picture which emerges from the two case studies is one which seems to preclude firm conclusions about the cost-effectiveness of or increases in productivity resulting from the innovations. However, some information does emerge concerning costs which seems useful. In the case of "Sesame Street," if the costs are divided by the large viewing audience, the costs per viewer reached are on the order of magnitude of one dollar per viewer per year, illustrating the economies of scale of open-circuit television.

In the CAI case, the number of users was more limited and the economies of scale not obvious. Early evaluations indicate CAI costs on the order of magnitude of a few dollars per student contact hour or a hundred dollars per student per year.* We were not able to obtain more recent data on the costs of the decentralized CAI now offered by Computer Curriculum Corporation. The federal government is currently supporting research and development into other CAI systems, i.e. PLATO-IV and TICCIT, which both seek to achieve improvements in per student contact hour costs.

The cost-effectiveness of an innovation depends in part on what the innovation accomplishes. In both case studies, the learning of cognitive skills was an important goal and in both case studies, the innovations were able to varying degrees, to bring this about, as indicated by the large-scale evaluations of "Sesame Street" by ETS and published evaluation of CAI experiments. However, it should be kept in mind in evaluating effectiveness and productivity that the learning of cognitive skills is but one element of the educational process.

It should be pointed out that there are serious difficulties associated with comparing costs and cost-effectiveness for "Sesame Street" and IMSSS-CAI. Both innovations, although to some extent concerned with teaching cognitive skills, were designed initially to be used by different audiences in different settings. The media they employ have different characteristics. In calculating costs, questions of start-up costs, R & D costs, cost for new equipment, etc. all arise. The role of the innovation, that is will it substitute for or supplement the teacher, becomes significant in questions of cost-effectiveness. It has been pointed out that CAI costs may in fact be competitive for "compensatory" education in which costs are incrementally greater than for conventional education.(5) Thus

*It should be stressed that these are order of magnitude costs. They are very rough but should suffice for purposes of comparison.

in considering cost-effectiveness, the context in which the innovation is to be used is of importance. It should also be mentioned that in both cases, there does not appear to be an obvious reduction of labor involved. CAI seems to require new layers of paraprofessional personnel. The same thing may be said about broadcast instructional television if one considers the utilization component subsequently added by CTW involving volunteer paraprofessionals. A more detailed study of cost-effectiveness or productivity would have the teacher-technology-paraprofessional trade-off and other issues to consider.

The issue of who pays which costs is an important one. If schools hard-pressed financially have to pay for a particular innovation out of their own funds, it may be difficult for them to do so unless they are convinced of the benefits which will accrue. Adopting IMSSS- (and subsequently CCC-) CAI took more of this kind of commitment than in the "Sesame Street" case. "Sesame Street" and its follow-on "The Electric Company" seem to involve little if any add-on expense to schools whereas CAI costs always wind up somehow being compared with the costs of traditional teacher-administered instruction. This situation reflects differences concerning who pays for what and the differing nature of the diffusion paths for the two innovations.

Another interesting issue revolves around whether the concept of productivity in education serves to foster or impede innovation. Although the productivity idea may prove attractive to government funding agencies and school administrators, this concept may be less attractive to teachers and even students. It would appear as though increasing "productivity" or "cost-effectiveness" was not a real motivating force behind "Sesame Street." It seemed to be more of a case of creative individuals wanting

to bring about improvements both in the children's television medium and in pre-school education. Much the same kind of motivation was probably present with the initial development of CAI. Costs of things are clearly important and the costs of CAI may need to come down for more widespread adoption to occur. But excessive concern over productivity in the field of education may serve to stifle innovation and discourage creative individuals. Improving the quality of education may, in the long run, prove to be a greater spur to innovation in education than the productivity concept.

E. On Assessing the Impacts of Innovations

In recent years, there has been growing interest in assessing the long-term impacts of innovations. The field of technology assessment has emerged which seeks to predict the consequences of new technological developments on individuals, organizations and the environment. Both "Sesame Street" and IMSSS-CAI are in a sense, technologies which may in fact have long-term effects, both good and bad on education, individuals and society. As the innovations appeared, so too did articles concerning these possible impacts.

An issue which arises in this regard is--under what circumstances should such assessment be performed concerning innovations in the field of education. In the two case studies, public funds were used to support the development of the innovations. At the same time, should public funds also be used to support an independent assessment of the potential impacts of innovations before they are widely adopted? The National Environmental Protection Act calls for such an assessment in matters affecting the physical environment. It may be that a parallel development would be desirable in the field of education. Innovation means change and change can be a

mixed blessing. Planning for beneficial change in education would seem to require attention to the issues raised here.

F. On the "Environment"

Both innovations were fielded during the 1960's when the federal government created many domestic social programs under the rubric of the "Great Society." Support for education was part of this effort. As events have transpired, the assumptions underlying both "The Great Society" and the role of education have come to be questioned in some quarters. The conclusions of Greer(6) and Jencks,(7) while not widely accepted, may be viewed as evidence of the educational revisionism propounded during the early 1970's. The macrocosmic environment has changed, and it may be in the direction of less popular support for innovation and a diminishing belief in education's efficacy as a change agent. Most likely this shift will have repercussions in terms of how clearly the public perceives any congruity between innovation and educational need.

However, the environment for large-scale technology-based innovations may have in fact improved since the 1960's. The public broadcasting organization seems on a firmer footing and near to achieving long-term funding. A recent report recommends increased involvement of public broadcasting in education.(8) Several large-scale projects, ATS-6, PLATO-IV, TICCIT, and UMA are underway, perhaps reflecting a trend to some extent away from smaller-scale local projects to demonstrations which are more regional in scope. In these projects, observability and trialability are "risked" to a greater extent in order to achieve economies of scale, and greater organizational complexity must be dealt with. The extent to which these innovations are accepted and contribute to improving education will be of considerable interest to educational planners and policy makers in the near future.

Both innovations, "Sesame Street" and IMSSS-CAI were supported in part by their orientation towards underserved or "disadvantaged" members of society. Yet, it seems likely that the initiating units functioned with very few inputs from the groups to be served. The need for broader participation in the development and evaluation of technology-based educational innovation on the part of minority professionals is a continuing challenge facing our society. ESEA funds permitted hard-pressed school districts to adopt CAI. Will the resources be there to sustain successful innovations or will they tend to be affordable only by more affluent districts? These issues deserve greater attention than they have received to date.

III. POLICY IMPLICATIONS; RECOMMENDATIONS FOR FURTHER RESEARCH

A. Is There a U.S. Policy With Regard To Innovation In Education?

An issue which emerges from the previous case studies and comparative analysis concerns whether or not there is a clear federal government policy with regard to innovation in the educational service sector. It appears to us that there in fact is such a policy, but instead of that policy being a conscious or structured one, it appears to have evolved from a series of separate actions involving various agencies and individuals.

Over the past ten to fifteen years, the federal government has acted as though it has sought to promote innovation in education, perhaps as part of a larger societally-held belief that innovation and change are intrinsically desirable. Although criteria for supporting innovations are not always well-defined, the case studies described previously and the technology-based projects currently underway indicate a pattern of support for innovation.

The push for innovation has been provided by a variety of circumstances and rationales. Organizations such as the U.S. Office of Education have been concerned with bringing about improvements in education. The National Science Foundation supports research and development in science and technology and is playing an important role in early CAI development. Productivity and cost-effectiveness, although difficult to define and measure in education, have emerged as motivating themes for innovation in the public service sector, including education. The impact of middle-level government officials, with technical backgrounds skilled in newer management techniques and concepts also undoubtedly contributed to this process.(9)

Specific federal legislation which served to spur the process of innovation in education includes the 1965 ESEA Titles and the National Defense Education Act. In the case of "Sesame Street," legislation in the 1960's which strengthened non-commercial broadcasting was a major factor. More recently, the National Science Foundation is supporting experiments with two-way cable and CAI. NIE is involved with the educational portion of the ATS-6 communications satellite experiment and with the television-based University of Mid-America, and HEW is supporting a Public Service Satellite Consortium, reflecting a possible trend towards larger-scale demonstrations. Legislation has been introduced which, if passed, would permit expanded federal support for broad-band communications in the public and educational sectors.(10)

Thus, the picture that emerges is that the federal government tends to be a major factor for innovation in education. However, it operates not through some clear-cut design but by a series of ad hoc steps that all tend to be supportive of innovation and change but which may produce erratic effects. Whether this pattern will continue or not would seem to depend on whether the over-all environment continues to be supportive of innovation and change. It may be that we are entering a period in which there is more concern with the possible impacts of innovation and change than there was previously, and more caution exercised in supporting innovations. A review of ESEA programs currently being carried out by NIE may possibly have important implications for future policy in this regard.

In the case of "Sesame Street," the innovation built upon both government and private foundation policy which supported the growth of educational and public television in the U.S. over the past two decades. Although government support came in many and varied ways, the distributional

base was there at the proper time. Having the necessary infrastructure for physical diffusion was not alone sufficient to insure adoption but seemed necessary for the technology in question.

CAI is at a much earlier stage in its development than educational television. Government agencies, including USOE, NSF and NIE, have supported a variety of approaches to CAI development in the 1960's and 1970's. At this writing, the outlook for widescale adoption of any CAI system remains uncertain. Whether the private sector will be able to serve as a major factor in a large-scale distribution system for CAI remains to be seen.

B. Recommendations for Further Research

1. Develop Criteria for Selecting Which Educational Innovations To Support

A useful outcome of these and other case studies might be to develop a set of criteria which would aid policy makers in choosing which innovations to support. Although such decisions are very complex, the innovation literature does appear to provide some useful information concerning which innovations are likely to be adopted. Classification of mainline versus ancillary innovations and criteria such as observability, trialability, flexibility, relative advantage and complexity do seem to explain differences in adoption rates of the two cases considered here. However, more research seems warranted in this regard.

2. Inventory Technology-Based Educational Innovations

An inventory of technologically-based educational innovations should be made so that policy makers will have a clear idea of what the federal support role has been and where the "quantum leaps" in utilization have occurred. This will aid in developing a better understanding of results obtained to date. It will also assist in developing a corpus of

knowledge relevant to continuing efforts to foster educational innovation. This effort should be undertaken in conjunction with the research outlined above to develop support criteria.

3. Develop Additional Case Studies

The case study approach seems to us to provide useful information both to educational planners and policy makers as well as to those more broadly interested in the process of innovation in the public service sector. Additional case studies would be pertinent to the research efforts noted above. The guidelines we employed were helpful in structuring the studies. We suggest that future work of this nature be undertaken on a selected basis. Selection of topics for future analysis should be made with the intent of producing a set of documents which will: 1) provide insight into those phases of the innovation cycle deemed most crucial, and 2) have some relevance to the other cases under study. A feedback loop between researchers engaged in the case study effort and in developing support criteria should be established so that the final products will have some congruity. In that way a data base will be assembled which it is hoped can be synthesized into fairly precise observations on the change cycle in education.

In line with this rationale, we feel that the instructional television program "The Electric Company" and the medical components of the ATS-6 satellite demonstration are innovations meriting further investigation. "The Electric Company's" open circuit delivery scheduled for both school and home reception deserves closer observation because of its acceptability in both settings. It is believed that a detailed analysis of this program would produce valuable insights, for here we appear to have an example of teachers serving as adopters on a fairly large scale. A similar recommendation has recently been made by the

Task Force on Elementary-Secondary and Teacher Education of the Advisory Council of National Organizations to the Corporation for Public Broadcasting when it called for decision-oriented research on the utilization patterns of television and radio in the schools.(8)

Case studies of technologically-based innovations in the health sector, while outside the purview of the NIE, should be scrutinized by educational policy makers because they may provide illuminating insights into the milieu and adoption of innovation in another public sector. Although the medical field appears to be a more likely adopter of technologically-based innovations than education, characteristics common to both health care and education would seem to impede change: highly-fragmented markets, geographic and professional disaggregation, and the presence of many "domains" and personal prerogatives are ready examples. Therefore, cooperation with the appropriate health agencies might be warranted so that meaningful case studies can be compiled. An example would be an analysis of the health demonstrations on ATS-6, with particular attention to the early, or formative, phases of the innovation cycle. A comparison of that analysis with a similar study of the education component of ATS-6 could produce additional useful findings.

4. Perform Additional Research on CAI

We found readily available information on CAI to be somewhat limited. There appears to be a need for more detailed research on CAI projects and outcomes, with particular emphasis on issues such as the role of government agencies and individuals in promoting or hindering innovation, more detailed considerations of cost-effectiveness, and the extent to which such projects fulfilled the objectives for which they were intended. Such research might be performed as part of the overall evaluation of ESEA programs now being carried out at NIE.

References - Chapter 4

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